SRWRS
Sacramento River Water Reliability Study

Initial Alternatives Report, Appendix C
Phase I Engineering Report

May 2004

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ACRONYMS AND ABBREVIATIONS

AOP	advanced oxidation process
ARPS	American River Pump Station
ATPS	Auburn Tunnel Pump Station
Ave	avenue
Blvd	boulevard
cfs	cubic feet per second
C*T	disinfection contact time
CTP	Cooperative Transmission Pipeline
dia	diameter
ea	each
floc/sed	flocculation/sedimentation
ft/sec	feet per second
HEC-RAS	Hydraulic Engineering Center River Analysis System (hydraulic model)
HI	Hydraulic Institute
hp	horsepower
hwy	highway
Interim Report	SRWRS Interim Report (June 2003)
lf	linear feet
ls	lump sum
mg	million gallons
mgd	million gallons per day
NGVD	National Geodetic Vertical Datum, 1929
NMWC	Natomas Mutual Water Company
O&M	operation and maintenance
PCWA	Placer County Water Agency
Reclamation	United States Department of the Interior, Bureau of Reclamation
Rd	road
Roseville	City of Roseville
ROW	right-of-way
RW	raw water
Sacramento	City of Sacramento
sf	square feet
SJWD	San Juan Water District
SRWRS	Sacramento River Water Reliability Study
SSWD	Sacramento Suburban Water District
TW	treated water
UNET	hydraulic model using one-dimensional unsteady flow through a network of open channels developed by USACE
USACE	United States Army Corps of Engineers
USGS	United States Geological Survey
UV	ultraviolet
WTP	water treatment plant

SUMMARY

This appendix presents an engineering analysis and refinement of five water supply alternatives currently considered in Phase I of the Sacramento River Water Reliability Study (SRWRS). These alternatives were developed to help serve the needs of the SRWRS cost-sharing partners: Placer County Water Agency (PCWA), Sacramento Suburban Water District (SSWD), the City of Roseville (Roseville), and the City of Sacramento (Sacramento).

INTRODUCTION

The primary objectives of this report are to define and describe the key elements of each of the water supply alternatives, assess key engineering advantages or difficulties associated with each alternative, and estimate the cost of each alternative. Ongoing Phase I activity includes a preliminary screening for initial alternatives currently considered and suggested in the scoping process. The preliminary screening process is described in **Appendix B** of the main report. A more detailed engineering analysis of remaining alternatives will be included in Phase II activities.

The water supply preliminary alternatives, Elkhorn/Elverta Diversion, Sankey Diversion, Feather River Diversion, American River Pump Station (ARPS), and Folsom Dam, were previously defined in the **Appendix B**.[1] As noted in the Interim Report, the five preliminary alternatives provide the following:

- Additional water supply to PCWA to meet water demands resulting from planned urban growth.
- Additional water supply to SSWD to enhance the groundwater stabilization project.
- Additional water supply to Roseville to meet water demands resulting from planned urban growth and facilitate a local conjunctive use program.
- Additional water supply capacity for Sacramento to ensure water supply reliability, and provide retail and wholesale water within its place of use and wheeling services to neighboring water purveyors to meet water demands and reduce groundwater reliance.

Facility components for the SRWRS cost-sharing partners vary with each alternative. The SRWRS cost-sharing partners provided information on the existing system and planned system development, and assisted in modifying and refining the alternatives. **Table C-1** presents a summary of the maximum firm capacity and diversion location for each of the cost-sharing partners under each preliminary alternative.

[1] SRWRS, Interim Report, June 2003.

Table C-1
Comparison of Maximum Firm Capacity and Diversion Location for Each SRWRS Cost-Sharing Partner by Preliminary Alternatives

Alternative	Facility	PCWA (mgd)	SSWD (mgd)	Roseville (mgd)	Sacramento (mgd)	Total (mgd)
Elkhorn/ Elverta Diversion	Elverta Road Diversion	65	15	10	165	255
Sankey Diversion	Elverta Road Diversion	0	0	0	165	165
	Sankey Road Diversion	65	15	10	0	90
Feather River Diversion	Elverta Road Diversion	0	0	0	165	165
	Feather River Diversion	65	15	10	0	90
ARPS	Elverta Road Diversion	0	0	0	165	165
	ARPS	65	0	0	0	65
	Other	0	Shoulder Capacity from SJWD	Increase Groundwater Use	0	25
Folsom Dam	Elverta Road Diversion	0	0	0	165	165
	Folsom Dam	65	0	0	0	65
	Other	0	Shoulder Capacity from SJWD	Increase Groundwater Use	0	25

Key:
ARPS – American River Pump Station
mgd - million gallons per day
PCWA – Placer County Water Agency
SJWD – San Juan Water District
SSWD – Sacramento Suburban Water District

DESCRIPTION OF PRELIMINARY ALTERNATIVES

The five preliminary alternatives are briefly described below.

Elkhorn/Elverta Diversion Alternative

The Elkhorn/Elverta Diversion alternative includes a raw water intake and pump station located on the Sacramento River, a raw water pipeline, a water treatment plant (WTP), and treated water pipelines. This alternative would provide water supply for all SRWRS cost-sharing partners from a new 255 million-gallon per day (mgd) joint diversion and a new joint WTP of the same capacity.

Sankey Diversion Alternative

The Sankey Diversion alternative includes two raw water intakes and associated pump stations located on the Sacramento River, two WTPs, raw water pipelines, and treated water pipelines. This alternative would provide water supply for Sacramento from a new 165 mgd separate diversion and WTP, while PCWA, Roseville, and SSWD would obtain water from a new 90 mgd joint diversion and joint WTP.

Feather River Diversion Alternative

The Feather River alternative includes two raw water intakes and associated pump stations, one located on the Feather River and one on the Sacramento River, two WTPs, raw water pipelines, and treated water pipelines. This alternative would provide water supply for Sacramento from a new 165 mgd separate diversion and WTP drawing from the Sacramento River, while PCWA, Roseville, and SSWD would obtain water from a new 90 mgd joint diversion and joint WTP drawing from the Feather River.

American River Pump Station Alternative

The ARPS alternative includes expanding the intake pumping capacity of PCWA's ARPS and constructing a new raw water intake and associated pump station located on the Sacramento River. The alternative also includes expanding the planned PCWA Foothill Phase II WTP and constructing a new WTP near the proposed Sacramento River intake. In addition, the alternative includes a raw water pipeline and treated water pipelines. This alternative would provide water supply for Sacramento from the new 165 mgd diversion while PCWA would obtain 65 mgd from expanded American River facilities. Roseville would meet its demands through increased groundwater pumping, and SSWD would meet its demands through the use of shoulder capacity from San Juan Water District's (SJWD) Peterson WTP. The nominal capacity of a water supply facility is sized typically for max-day or peak-day demand, which occurs in summer. Therefore, there are times during a year when the total capacity of the facility is not used for the scheduled demand. The unused capacity during those periods is often referred to as "shoulder capacity." This capacity can be made available to others to maximize or optimize the use of the facility.

Folsom Dam Alternative

The Folsom Dam alternative includes constructing a tie-in to the existing Folsom Dam penstocks, a new raw water pump station, and a new raw water intake and associated pump station located on the Sacramento River. The alternative also includes expanding SJWD's Peterson WTP and constructing a new WTP near the proposed Sacramento River intake. In addition, the alternative includes raw water pipelines and treated water pipelines. This alternative would provide water supply for Sacramento from the new 165 mgd diversion, while PCWA would obtain 65 mgd from the new penstock connection and expanded SJWD Peterson WTP. Roseville would meet its demands through increased groundwater pumping, and SSWD would meet its demands through the use of shoulder capacity from SJWD's expanded Peterson WTP.

ENGINEERING ASSESSMENT OF ALTERNATIVES

Key engineering advantages and difficulties associated with each of the five alternatives are discussed below.

Elkhorn/Elverta Diversion Alternative

- Location of the combined Sacramento River intake near Elverta Road has excellent available water depth, which allows design flexibility and potential for reducing the intake structure footprint and construction cost. The small footprint will also be favored by permitting agencies.

- Proposed intake location would be superior to an alternative site owned by Natomas Mutual Water Company (NMWC). The alternative site, located near Elkhorn Boulevard, was not retained due to limited available water depth for a major M&I diversion that may require higher reliability for its service.

- Minimal disturbance would occur to the public from locating the intake and WTP adjacent to airport property and the commercially zoned property near the airport.

- High water table and potentially unfavorable soils conditions could increase construction cost.

- Challenging roadway and water crossings for pipelines would include Highway 99, Union Pacific Railroad, Dry Creek, Pleasant Grove Creek, East Drainage Canal, and Natomas East Main Drainage Canal.

Sankey Diversion Alternative

- Construction of two intakes in relatively close proximity (within 4-1/2 miles), rather than one combined intake, could be less acceptable to permitting agencies.

- The United States Army Corps of Engineers (USACE) could modify the levee setback at the Sankey Road intake for flood management purposes, which could increase construction cost and/or require future modifications of the facility.

- High water table and potentially unfavorable soils conditions could increase construction cost.

- Challenging roadway and water crossings for pipelines would include Highway 99 (twice), Union Pacific Railroad, Dry Creek, Pleasant Grove Creek, East Drainage Canal, and Natomas East Main Drainage Canal.

Feather River Diversion Alternative

- Construction of two intakes in relatively close proximity (approximately 15 miles), rather than one combined intake, could be less acceptable to permitting agencies.

- Feather River has widely spaced levees that could allow the river to meander away from the proposed intake, thereby decreasing water system reliability and potentially increasing costs.

- Limited available water depth at the Feather River intake would increase the structural footprint and construction cost.

- Long access bridge required at the Feather River intake would increase cost, environmental impacts, and permitting difficulties.

- High water table and potentially unfavorable soil conditions could increase construction cost.

- Challenging roadway and water crossings for pipelines would include Highway 99, Union Pacific Railroad, Dry Creek, Pleasant Grove Creek, and East Drainage Canal. In addition, the pipeline would cross several smaller unnamed creeks and low-lying areas.

American River Pump Station Alternative

- This alternative would be the lowest capital cost alternative.

- Foothill Phase II WTP facility is planned to be constructed in 2005 to accommodate future expansion, which would reduce time and cost for construction.

- Pipeline construction would be challenging and expensive because the area is hilly and rocky and in some areas the rock is only marginally rippable.

- Challenging roadway and water crossings for pipelines would include Highway 65 and Pleasant Grove Creek. In addition, the Highway 193/Taylor Road intersection area would be particularly challenging due to steep terrain and tunnel and railroad crossings.

Folsom Dam Alternative

- Detailed coordination with Reclamation would be required. Potential would exist for conflicts with other users of water from penstocks, including energy generators.

- Pipeline alignment would be constructed through high-density development.

- Challenging water crossings for pipelines would include Pleasant Grove Creek and Dry Creek. In addition, pipeline crossings of Interstate 80 and the Roseville railyard would be particularly challenging.

OPINION OF COSTS

Table C-2 summarizes the capital cost generated for each alternative.

Table C-2
Capital Cost Summary for Alternatives[1]

Description	Elkhorn/Elverta Diversion Alternative	Sankey Diversion Alternative	Feather River Diversion Alternative	American River Pump Station Alternative[2]	Folsom Dam Alternative[2]
Intake Structure and Raw Water Conveyance Pipelines	$39,258,000	$75,493,000	$76,068,000	$34,502,000	$37,992,000
Water Treatment Facilities	$159,650,000	$184,790,000	$184,790,000	$157,940,000	$159,165,000
Treated Water Conveyance Pipelines	$118,302,000	$88,926,000	$98,236,000	$95,538,000	$91,395,000
Subtotal	**$317,210,000**	**$349,209,000**	**$359,094,000**	**$296,780,000**	**$297,352,000**
Engineering, Environmental, Administration, and Legal Services (30%)	$95,170,000	$104,770,000	$107,730,000	$89,034,000	$89,206,000
Contingency (25%)	$103,100,000	$113,500,000	$116,710,000	$96,454,000	$96,639,000
Total Cost	**$515,500,000**	**$567,500,000**	**$583,600,000**	**$482,268,000**	**$483,197,000**

[1] Does not include costs for easements, land purchases, or future advanced oxidation processes.

[2] Subtotals for both the American River Pump Station and Folsom Dam alternatives include Roseville groundwater pumping and treatment facilities.

PRELIMINARY DESIGN METHODS, CRITERIA, AND ASSUMPTIONS

Following are preliminary design methods, criteria, and assumptions used in developing the five alternatives.

GENERAL

- All elevations are referenced to the National Geodetic Vertical Datum, 1929 (NGVD), unless otherwise noted.

NEW RIVER DIVERSION FACILITIES

- Bathymetric and topographic information developed by USACE, preliminary river flow/stage analysis, aerial photography, and field investigations were used to evaluate potential river intake sites.

- Preliminary flow/stage analyses were performed using HEC-RAS and UNET models developed by USACE for the Sacramento-San Joaquin River Basins Comprehensive Study, and flow records from the United States Geological Survey (USGS) for Sacramento River at Verona (Station No. 11425500) and Feather River at Nicolaus (Station No. 11425000). The 90 percent exceedence, 10 percent exceedence, and 100-year flood water surface elevations were calculated for each Sacramento River and Feather River intake alternative. By definition, water in the river is higher than the 90 percent exceedence water surface 90 percent of the time. This elevation is typically used to define the elevation of the top of required intake fish screens to assure a fully submerged condition 90 percent of the time.

- Intake sites were selected to maximize available river depth. A greater depth to river bottom is an asset as it allows the intake structure to be constructed deeper, with a smaller overall footprint in the river, which results in less cost and less environmental impact. (The intake structure would have a smaller footprint because the area of fish screen required below the low water surface[2] is fixed by regulatory agency standards (0.33 feet per second [ft/sec] approach velocity), and since area = length x depth, the length of the fish screen could be reduced if the depth was increased.)

- Intake sites on the outside bend of the river and between defined levees were preferred for selection. Locating on the outside bend of the river reduces the chance of sediment buildup since water is moving faster than on the inside bend. Locating in a narrow reach between defined levees reduces the chance that the river will meander away from the intake.

- Intake sites farther away from homes were preferred. Operational pump noise and maintenance activities may cause residential neighbors to oppose construction of facilities and request limitations on activities and increased noise restrictions.

- All in-river intake structures were assumed to be constructed as oblong piers with fish screens on both sides and with bridges providing access from adjacent levees. This assumption allowed direct comparisons between alternatives. The width of the piers was assumed to be 30 feet, as required for maintenance access. Bridges were also assumed to be 30 feet wide.

[2] The low water surface is typically defined as the lowest monthly 90 percent exceedence elevation.

- The lengths of the intake structures were calculated based on a combination of available river depth and vertical pump spacing according to Hydraulic Institute[3] (HI) standards. This was a conservative approach since HI spacing diminishes the potential footprint reduction that might be gained where greater water depth is available. In the absence of a detailed analysis of alternative intake structure configurations for each site, however, this assumption was necessary to establish a basis of comparison between alternatives. It is assumed that configurations that take better advantage of available water depth, and thereby reduce the environmentally sensitive footprint, will be developed as part of a subsequent phase of this project.

- A 200-foot-wide construction corridor extending from the intake structure to the adjacent levee was assumed for in-river intakes.

WATER TREATMENT FACILITIES

- Aerial photography,[4] current street maps, and field investigations were used to evaluate potential plant sites.

- The land area required for new WTPs was assumed to be approximately 0.4 acres per mgd. A portion of the sites (approximately 20 percent) was reserved for a combination of storm water detention and potential habitat conservation elements.

- As a conservative approach, conventional treatment trains were assumed for all new WTPs. A review of available water quality information and the 2000 Update to the Sacramento River Watershed Sanitary Survey[5] indicate that 3/4/2-log reduction of *Giardia*/virus/*Cryptosporidium* likely is appropriate at this time. Data also indicate a potential seasonal treatment concern for rice herbicides, which can be mitigated through selected chemical oxidation processes.

- Disinfection contact time (C*T) tanks for the Elkhorn/Elverta Diversion, Sankey Diversion, and the Feather River Diversion alternatives were sized to achieve 0.5-log *Giardia* inactivation (approximately 15 minutes).

- Clearwell facilities for the Elkhorn/Elverta Diversion, Sankey Diversion, and the Feather River Diversion alternatives were sized assuming 10 percent of plant capacity.

- The Foothill Phase II[6] WTP location and layout for the American River Pump Station Alternative were provided by PCWA.

- The expansion of SJWD's Peterson WTP for the Folsom Dam Alternative was extrapolated from the Wholesale Master Plan[7] prepared by the engineering firm of Kennedy-Jenks in 2001.

- Requirements for pumping to the transmission system were approximated, based on preliminary pressure conditions obtained from the cost-sharing partners; costs for pumping facilities were included in the overall facility cost.

---

[3] Hydraulic Institute. American National Standard for Vertical Pumps for Design and Applications. Parsippany, New Jersey: Hydraulic Institute. (January, 2000)
[4] Air Photo USA. Flown in November 2002. Phoenix, Arizona.
[5] MWH. Sacramento River Watershed Sanitary Survey – 2000 Update. (December, 2000)
[6] Black & Veatch. 2003. Foothill Phase II Water Treatment Plant Initial Planning and Siting Study - Site Development Evaluation. Draft Memorandum. August.
[7] Kennedy-Jenks Consultants. Wholesale Master Plan Water Supply and Treatment. (September, 2001)

- Fluoridation-related costs and facilities were included for Sacramento and Roseville because both cities currently fluoridate their treated water.

PIPELINES

- Aerial photography,[8] current street maps, existing system information provided by the cost-sharing partners, and field investigations were used to evaluate potential pipeline alignments. The criteria and methods used to determine the preferred alignment included avoiding encroachment into private property, following the most direct route on a roadway or existing right-of-way (ROW), avoiding major disruption to existing utilities, and, if possible, avoiding highly populated areas. Areas subject to flooding were avoided where possible to reduce construction risk and cost.

- Pipeline alignments shown are approximate. It is assumed that the final location of the pipelines would be within an approximately 200-foot-wide corridor centered on the pipeline alignment shown.

- The target flow velocity of water in raw and treated water pipelines was 5 feet per second, but not to exceed 6 feet per second.

OPINION OF COSTS

- Capital costs for construction have been generated for each alternative.

- Intake and WTP construction costs are based on actual bid costs for similar Sacramento-area facilities. Unit costs were scaled from bid costs based on flow rates and engineering judgement.

- A unit-installed-cost of $9 per diameter-inch/foot was assumed for typical pipelines. For areas where extensive hard rock excavation was expected, a unit-installed cost of $10 per diameter inch/foot was assumed.

- The cost for engineering, environmental, administration, and legal work was assumed to be 30 percent of construction cost.

- No costs for easements, land purchase, or future advanced oxidation processes were included.

- A 25 percent contingency was included in all costs.

- Operation and maintenance (O&M) costs were not quantified for these alternatives since minimal information is available to generate reasonable levels of cost. For relative comparison purposes, a qualitative assessment was conducted and a summary is presented in each alternative and Attachment A.

[8] Air Photo USA. Flown in November 2002. Phoenix, Arizona.

DESCRIPTION OF ALTERNATIVES

In the following sections, elements of each alternative are described, including diversion facilities and raw water conveyance pipelines, water treatment facilities, and treated water pipelines. In addition, an opinion of cost is given for each alternative.

ELKHORN/ELVERTA DIVERSION ALTERNATIVE

The elements of this alternative are depicted in **Figures C-1 through C-3** and summarized in **Table C-3**. **Figure C-1** shows an overview of the project while **Figures C-2 and C-3** show details of intake facilities

Table C-3
Inventory of Required Facilities for the Elkhorn/Elverta Diversion Alternative

DIVERSION FACILITY						
Capacity (mgd)	**Location**	**Description/Notes**	**Cost-Sharing Partners Served**			
255	Sacramento River - Garden Hwy near Elverta Rd	New intake facility, approximately 1.3 acres	Sacramento, PCWA, SSWD, Roseville			
WATER TREATMENT FACILITY						
Capacity (mgd)	**Location**	**Description/ Notes**	**Cost-Sharing Partners Served**			
255	On Elverta Rd approximately 1 mile east of Garden Hwy	New WTP, approximately 100 acres	Sacramento, PCWA, SSWD, Roseville			
RAW WATER CONVEYANCE PIPELINES						
Pipeline Segment Start	**Pipeline Segment End**	**Description/ Notes**	**Max Flow Rate (mgd)**	**Maximum Diameter (inches)**	**Approximate Length (miles)**	**Cost-Sharing Partners Served**
Garden Hwy/Elverta Rd Intake Facility	Elverta Rd/Garden Hwy WTP	Under levee, through agricultural lands and within or adjacent to road right-of-way	255	Dual 84	1.0	Sacramento, PCWA, SSWD, Roseville
TREATED WATER CONVEYANCE PIPELINES						
Pipeline Segment Start	**Pipeline Segment End**	**Description/Notes**	**Max Flow Rate (mgd)**	**Maximum Diameter (inches)**	**Approximate Length (miles)**	**Cost-Sharing Partners Served**
Elverta Rd/Garden Hwy WTP	Intersection of East Drainage Canal and Del Paso Rd	Routed south parallel to East Drainage Canal to Del Paso Rd	165	96	8.0	Sacramento
Elverta Rd/Garden Hwy WTP	Intersection of Fiddyment Rd and Blue Oaks Blvd	First section of pipeline carries flow from the three affected cost-sharing partners, with turn-off at Baseline Rd and Watt Ave (SSWD)	90	72	18.8	SSWD, Roseville, PCWA
Intersection Baseline Rd and Watt Ave	Intersection of Antelope Rd and Walerga Rd	Connect to 48-inch Cooperative Transmission Pipeline/Northridge Transmission Pipeline	15	48	4.0	SSWD
Intersection of Fiddyment Rd and Blue Oaks Blvd	Intersection of Fiddyment Rd and Athens Rd	Pipeline routed via Fiddyment Rd to PCWA tie-in	80	66	3.8	PCWA

and water treatment facilities, respectively. The Elkhorn/Elverta alternative includes a raw water intake and pump station located on the Sacramento River, a raw water pipeline, a WTP, and treated water pipelines (see **Figure C-1**). This alternative would provide water supply for all SRWRS cost-sharing partners from a new 255-mgd joint diversion and a new joint WTP of the same capacity.

Diversion Facilities and Raw Water Conveyance Pipelines

The intake site selection search included an approximately 3-mile stretch of the river in the vicinity of the location generally identified in the Interim Report. **Figure C-2** shows the proposed intake site, located approximately at river mile 74.6.

The proposed site was selected primarily due to its superior hydraulic suitability. The 90 percent exceedence water surface elevation at the proposed site was approximately 5.6 feet. With a river bottom elevation of at least –16.0 feet, the available water depth at the site would be 21.6 feet (see **Figure C-B1** in Attachment B). Additional hydraulic benefits of the proposed site are its location in the outside bend of the river and in a narrow reach between defined levees.

An alternative site at the current Natomas Mutual Water Company (NMWC) intake near Elkhorn Boulevard was considered because it was theorized that the cost-sharing partners might combine with NMWC to construct a joint facility. The primary reason the Elkhorn site was rejected was that its limited available water depth would have increased the size and complexity of the intake structure. **Figure C-C1** in Attachment C shows the location of the Elkhorn site and provides bathymetric information for the "Elkhorn" site and the proposed site at Elverta Road. **Tables C-C1 and C-C2** in **Attachment C** summarize perceived advantages and disadvantages of the two sites to the cost-sharing partners and NMWC.

The proposed site is located within the current "Overflight Zone" but outside the "Approach/Departure Zone" for the Sacramento International Airport, as defined by the airport's "Land Use Compatibility Guidelines for Safety." However, the site will be located within the "Approach/Departure Zone" for a newly proposed "West" runway. This does not preclude development of the site, but does require additional coordination with Airport representatives. The property is currently owned by the County of Sacramento. The location in close proximity to the airport is advantageous in that no residential housing is adjacent or near the proposed facility.

The intake structure would be approximately 185 feet long, based on HI pump spacing requirements, and the access bridge would be approximately 380 feet long. The area of land on the river side of the levee that would be affected by intake construction is approximately 1.3 acres. Raw water would exit the intake facility via two 84-inch diameter pipelines for operational redundancy and constructibility, and be pumped to the proposed WTP, approximately 1 mile east. A pumping head of approximately 50 feet would be required to convey the 255 mgd flow.

Water Treatment Facility

Figure C-3 shows the proposed site for the 255 mgd Elverta Road WTP, located approximately 1 mile east of Garden Highway on Elverta Road. The site was initially identified by Sacramento and is located within the "Overflight Zone" but outside the Approach/Departure Zone" of Sacramento International Airport, both for existing and proposed runways. The terrain of the proposed site is flat, approximately 100 acres in area, and currently used for farming.

Raw water would enter the site from the west via two 84-inch pipelines. Treated water would exit the site towards the east via a 96-inch pipeline that would serve Sacramento and a 72-inch pipeline that would serve PCWA, Roseville, and SSWD.

The facility would comprise conventional treatment processes, including a grit basin, flocculation/sedimentation (floc/sed) basins, filters, C*T tank clearwell, backwash water basin, electrical building, chemical building, operations building, solids handling area, and storm water detention/habitat conservation program area. In addition, physical and hydraulic space was reserved for an advanced oxidation process (AOP), such as ozone or ultraviolet (UV) light, which would accommodate future drinking water regulations. A high-service pump station would move treated water to the distribution system.

Treated Water Conveyance Pipelines

The Elkhorn/Elverta Alternative treated water pipeline would follow two alignments from the Elverta Road WTP: one alignment would lead to Sacramento's system and the other alignment would lead to the tie-in point of the PCWA, Roseville, and SSWD systems. Routes are described as follows (see **Figure C-1**):

Sacramento Portion

- From the Elverta Road WTP, a 96-inch pipeline would head east approximately 3.5 miles along Elverta Road.
- At the intersection of Elverta Road and the East Drainage Canal, the pipeline would turn south and follow the canal for approximately 4.5 miles to Sacramento's tie-in point at Del Paso Road

PCWA, Roseville, and SSWD Portion

- From the Elverta Road WTP, a 72-inch pipeline would head east approximately 5.5 miles along Elverta Road.
- The pipeline would turn north for approximately 2.6 miles along the Sorrento Road/Pleasant Grove Road.
- The pipeline then would turn east for approximately 5.6 miles along Riego/Baseline Road.
- At the intersection of Baseline Road and Watt Avenue, the 72-inch diameter pipeline would bifurcate into a 48-inch pipeline that would serve SSWD, and a 72-inch pipeline that would continue east and serve Roseville and PCWA.
- The 48-inch pipeline serving SSWD would follow Watt Avenue south approximately 3.5 miles to Antelope Road.[9]
- The 48-inch pipeline then would turn east on Antelope Road to Walerga Road to the SSWD tie-in point (connecting to the Cooperative Transmission Pipeline (CTP)).
- The 72-inch pipeline serving PCWA and Roseville would continue east along Baseline Road for approximately 1.8 miles to Fiddyment Road.
- The 72-inch pipeline then would turn north on Fiddyment Road for approximately 2.7 miles to the Roseville tie-in point at Fiddyment Road and Blue Oaks Boulevard.[10]

[9] An alternative alignment routed south along Walerga Road has been identified and will be evaluated during Phase II engineering analysis.

- A 66-inch pipeline would continue north approximately 3.7 miles along Fiddyment Road to the tie-in point for PCWA at Fiddyment Road and Athens Road.

Opinion of Cost

A cost breakdown for the Elkhorn/Elverta Diversion alternative is presented in **Table C-4**. The opinion of total capital cost for all facilities, including costs for engineering, environmental, administration, and legal services, and a 25 percent contingency is $515,500,000.

The overall O&M costs for this alternative are expected to be the mid-range of all alternatives. Diversion facilities are expected to have lower costs than most other alternatives, and treatment and pumping facilities are expected to have near average costs, while pipeline O&M costs will likely be the most since this alternative has the most miles of pipeline. Attachment A provides a summary of the assessment.

[10] An alternative alignment, routed cross-country north through Roseville's water storage tank site, has been identified and will be incorporated into the Phase II engineering analysis.

Table C-4
Opinion of Capital Cost for Elkhorn/Elverta Diversion Alternative

(Estimate does not include costs for easements, land purchase, or future advanced oxidation processes.)

Description	Unit	Quantity	Cost	Extended Cost
INTAKE STRUCTURE AND RAW WATER CONVEYANCE PIPELINES				
Sacramento River Intake Structure at Elverta Rd	ls	1	$ 32,000,000	$ 32,000,000
RW Conveyance Pipelines (dual 84" dia.)	lf	9,600	$ 756	$ 7,258,000
Subtotal				**$ 39,258,000**
TREATMENT FACILITY ON ELVERTA ROAD[1]				
Grit Basin and Flash Mix Structure	mgd	255	$ 55,000	$ 14,025,000
Flocculation/Sedimentation Basins	mgd	255	$ 110,000	$ 28,050,000
Filters	mgd	255	$ 145,000	$ 36,975,000
Waste Washwater Equalization System	mg	1	$ 2,500,000	$ 2,500,000
Chemical Systems(1)	ls	1	$ 4,350,000	$ 4,350,000
Chemical Building	ls	1	$ 4,000,000	$ 4,000,000
Operations/Administration Building	ls	1	$ 4,000,000	$ 4,000,000
Sludge Lagoons	sf	500,000	$ 14	$ 7,000,000
C*T Tank	mg	2.5	$ 1,200,000	$ 3,000,000
Treated Water Reservoir (Clearwell)	mg	25	$ 750,000	$ 18,750,000
Treated Water Pump Station	hp	10,000	$ 1,500	$ 15,000,000
Yard Piping	ls	1	$ 4,500,000	$ 4,500,000
Site Work and Landscaping	ls	1	$ 2,500,000	$ 2,500,000
Electrical, Instrumentation, and Controls	ls	1	$ 15,000,000	$ 15,000,000
Subtotal				**$ 159,650,000**
TREATED WATER CONVEYANCE PIPELINES				
TW Conveyance Pipeline (96" dia.)	lf	42,000	$ 864	$ 36,288,000
TW Conveyance Pipeline (72" dia.)	lf	94,000	$ 648	$ 60,912,000
TW Conveyance Pipeline (66" dia.)	lf	20,000	$ 594	$ 11,880,000
TW Conveyance Pipeline (48" dia.)	lf	21,000	$ 432	$ 9,072,000
Roseville Fluoridation Dosing Station	ls	1	$ 150,000	$ 150,000
Subtotal				**$ 118,302,000**
Elkhorn/Elverta Diversion Alternative (All Facilities) Opinion of Cost Subtotal				**$ 317,210,000**
Engineering, Environmental, Administration, and Legal Services	30%			$ 95,170,000
Subtotal				**$ 412,380,000**
Contingency	25%			$ 103,100,000
OPINION OF TOTAL CAPITAL COST				**$ 515,500,000**

[1] Includes Sacramento's Fluoridation Dosing Station

Key:

C*T	disinfection contact time	mg	million gallons
dia.	diameter	mgd	million gallons per day
hp	horsepower	RW	raw water
lf	linear feet	sf	square feet
ls	lump sum	TW	treated water

SANKEY DIVERSION ALTERNATIVE

The elements of this alternative are depicted in **Figures C-4 through C-6** and summarized in **Table C-5**. **Figure C-4** shows an overview of the project while **Figures C-5 and C-6** show details of intake facilities and water treatment facilities, respectively. The Sankey Diversion alternative includes two raw water intakes and associated pump stations located on the Sacramento River, two WTPs, raw water pipelines, and treated water pipelines (see **Figure C-4**). This alternative would provide water supply for Sacramento from a new 165 mgd separate diversion and WTP, while PCWA, Roseville, and SSWD would obtain water from a new 90 mgd joint diversion and joint WTP.

Diversion Facilities and Raw Water Conveyance Pipelines

Diversion facilities and pipelines for the Sacramento portion and the PCWA, Roseville, and SSWD portion of this alternative are described below.

Sacramento Portion

As noted above, the Sankey diversion alternative includes a separate intake for Sacramento. This intake would be built at the same location described in the Elkhorn/Elverta diversion alternative, as shown in **Figure C-5**. The intake structure's length would be approximately 150 feet, based on HI pump spacing requirements for the reduced diversion capacity, with the access bridge approximately 380 feet long (see **Figure C-B2** in Attachment B). Water would exit the intake facility via two 66-inch diameter pipelines for operational redundancy and constructibility, and be pumped to the proposed WTP, approximately 1 mile east. Pumping head requirements for the intake would be similar to requirements for the joint Elkhorn/Elverta diversion, approximately 50 feet.

PCWA, Roseville, and SSWD Portion

The proposed intake facility near Sankey Road, which would serve PCWA, Roseville, and SSWD, would be located south of the Natomas Cross Canal. The site investigation area included an approximately 2-mile stretch of the river south of the Natomas Cross Canal, as generally identified in the Interim Report. The proposed site, located approximately at river mile 79.0, is presented in **Figure C-5**. An alternative site immediately north of the Natomas Cross Canal was considered but rejected due to construction difficulties and additional costs associated with tunneling under the Natomas Cross Canal to reach desired system tie-in points. The rejected alternative also would have required coordination with the Pleasant Grove-Verona Mutual Water Company, which currently has plans for its own intake facility at the site.

The 90 percent exceedence water surface elevation at the proposed site was approximately 6.2 feet. With a river bottom elevation of approximately –4.0 feet, the available water depth at the site would be 10.2 feet (see **Figure C-B3** in Attachment B). HI pump spacing standards would govern at this available water depth and flow rate and the intake would be approximately 113 feet long, while the access bridge would be 180 feet long. The area of land on the river side of the levee that would be affected by intake construction is approximately 0.6 acres.

The proposed site is located in the outside bend of the river in a narrow reach between defined levees. The site is approximately 1.5 miles north of a grouping of private homes and is immediately south of a mobile home park and boat dock at the mouth of the Natomas Cross Canal. Property ownership for this site has not yet been determined but it is assumed that the land is privately owned. Proximity to existing residential development may be a disadvantage for this alternative.

Table C-5
Inventory of Required Facilities for the Sankey Alternative

DIVERSION FACILITIES			
Capacity (mgd)	**Location**	**Description/Notes**	**Cost-Sharing Partners Served**
90	Sacramento River - Garden Hwy near Sankey Rd	New intake facility, approximately 0.6 acres	PCWA, SSWD, Roseville
165	Sacramento River - Garden Hwy near Elverta Rd	New intake facility, approximately 1.3 acres	Sacramento

WATER TREATMENT FACILITIES			
Capacity (mgd)	**Location**	**Description/Notes**	**Cost-Sharing Partners Served**
90	Intersection of Sankey Rd and Brewer Rd	New WTP, approximately 40 acres	PCWA, SSWD, Roseville
165	On Elverta Rd approximately 1 mile east of Garden Hwy	New WTP, approximately 70 acres	Sacramento

RAW WATER CONVEYANCE PIPELINES						
Pipeline Segment Start	**Pipeline Segment End**	**Description/Notes**	**Max Flow Rate (mgd)**	**Maximum Diameter (inches)**	**Approximate Length (miles)**	**Cost-Sharing Partners Served**
Garden Hwy/Sankey Rd Intake Facility	Sankey Rd/Brewer Rd WTP	Under levee, under agricultural fields	90	72	8.0	PCWA, SSWD, Roseville
Garden Hwy/Elverta Rd Intake Facility	Elverta Rd/Garden Hwy WTP	Under levee, under agricultural fields	165	Dual 66	1.0	Sacramento

TREATED WATER CONVEYANCE PIPELINES						
Pipeline Segment Start	**Pipeline Segment End**	**Description/Notes**	**Max Flow Rate (mgd)**	**Maximum Diameter (inches)**	**Approximate Length (miles)**	**Cost-Sharing Partners Served**
Sankey Rd/Brewer Rd WTP	Intersection of Blue Oaks Blvd and Fiddyment Rd	First section of pipeline carries flow from the three affected cost-sharing partners	90	72	6.0	SSWD, Roseville, PCWA
Intersection Blue Oaks Blvd and Fiddyment Rd	Intersection of Fiddyment Rd and Baseline Rd	Routed via Fiddyment Rd to PCWA (Placer Vineyards) tie-in	29	48	2.8	SSWD, PCWA
Intersection of Fiddyment Rd and Baseline Rd	Antelope Rd and Walerga Rd	Connect to 48-inch Cooperative Transmission Pipeline/Northridge Transmission Pipeline	15	48	5.9	SSWD
Intersection Blue Oaks Blvd and Fiddyment Rd	Intersection of Fiddyment Rd and Athens Rd	To PCWA tie-in	80	66	3.8	PCWA
Elverta Rd/Garden Hwy WTP	Intersection of East Drainage Canal and Del Paso Rd	Routed south parallel to East Drainage canal to Del Paso Rd	165	96	8.0	Sacramento

An additional disadvantage for the Sankey diversion alternative is pending USACE levee modification work. The easterly levee along the proposed intake site may be moved 50 to 1,000 feet away from the river as part of USACE's American River Watershed Project (Common Features).[11] This project includes modifications to Sacramento River levees to accommodate backwater that results during high flows in the American River. Resulting impacts on the proposed alternative, depending on the timing of final design and construction of the levee modification project, could be significant. The levee modification could require an exceptionally long intake access bridge or could adversely affect available river depth.

Raw water would exit the intake facility via a single 72-inch diameter pipeline and would be pumped to the proposed WTP, approximately 8 miles east along Sankey Road. A pumping head of approximately 90 feet would be required to convey the 90 mgd flow.

Water Treatment Facilities

Water treatment facilities for the Sacramento portion and the PCWA, Roseville, and SSWD portion of this alternative are described below.

Sacramento Portion

The proposed site for the 165-mgd WTP is the same as for the Elkhorn/Elverta Diversion alternative, except that individual treatment processes would be reduced in size to reflect the reduced plant capacity. The 165-mgd WTP site is shown in **Figure C-6**. The area required for the proposed site would be reduced to approximately 70 acres. Raw water would enter the site from the west via two 66-inch pipelines and treated water would exit the site towards the east via a 96-inch pipeline that would serve Sacramento.

PCWA, Roseville, and SSWD Portion

The proposed site for the 90-mgd WTP is also shown in **Figure C-6**. The site is located approximately 8 miles east of Garden Highway on Sankey Road at its intersection with Brewer Road. The terrain of the proposed site is flat, approximately 40 acres in area, and currently used for farming.

Raw water would enter the site from the west via a 72-inch pipeline. Treated water would exit the site towards the east via a 72-inch pipeline that would serve PCWA, Roseville, and SSWD.

As with the Sacramento site, facilities would comprise conventional treatment processes, including a grit basin, floc/sed basins, filters, C*T tank, clearwell, backwash water basin, electrical building, chemical building, operations building, solids handling area, and storm water detention/habitat conservation program area. In addition, physical and hydraulic space would be reserved for an AOP, such as ozone or UV light, which would accommodate future drinking water regulations. A high-service pump station would move treated water to the distribution system.

Treated Water Conveyance Pipelines

The Sankey Diversion Alternative treated water pipeline follows two alignments: one alignment would lead to Sacramento from the Elverta Road WTP and the other would lead to PCWA, Roseville, and SSWD from the Sankey Road WTP. Routes are described below (see **Figure C-4**).

[11] MWH. 2002. Sacramento River east bank levee strengthening design alternatives considered by USACE.

Sacramento Portion

The treated water pipeline alignment and capacity are identical to those described in the Elkhorn/Elverta Diversion Alternative.

PCWA, Roseville, and SSWD Portion

- From the Sankey Road WTP, a 72-inch diameter pipeline would head east along Sankey Road for approximately 4 miles.
- The 72-inch pipeline would turn north for approximately 0.6 miles to Phillip Road.
- The 72-inch pipeline then would turn east on Phillip Road/Blue Oaks Boulevard for approximately 1.5 miles to the Roseville tie-in point at Fiddyment Road and Blue Oaks Boulevard.
- At the intersection of Fiddyment Road and Blue Oaks Boulevard, the pipeline would bifurcate into a 66-inch pipeline that would serve PCWA and a 48-inch pipeline that would serve SSWD and PCWA (Placer Vineyards).
- The 66-inch pipeline would turn north following Fiddyment Road for approximately 3.7 miles to the PCWA tie-in point at Fiddyment Road and Athens Road.
- The 48-inch pipeline would turn south for approximately 2.8 miles along Fiddyment Road to the PCWA (Placer Vineyards) tie-in point at Fiddyment Road and Baseline Road.
- The 48-inch pipeline would turn west on Baseline Road and continue for approximately 1.8 miles.[12]
- The 48-inch pipeline then would turn south on Watt Avenue for approximately 3.6 miles to Antelope Road.
- At Antelope Road, the 48-inch pipeline would turn east to Walerga Road to the SSWD tie-in point at Walerga Road and Antelope Road (connecting to the CTP).

Opinion of Cost

A cost breakdown for the Sankey Diversion alternative is presented in **Table C-6**. The opinion of total capital cost for all facilities, including costs for engineering, environmental, administration, legal services, and a 25-percent contingency is $567,500,000.

The overall O&M costs for this alternative are expected to be higher than for most of the alternatives. Diversion facilities are expected to have higher than average costs, and treatment and pumping are expected to have higher than average costs, while pipeline O&M will likely be the least expensive since this alternative has the fewest miles of pipeline. Attachment A provides a summary of the assessment.

[12] An alternative alignment for the remainder of this pipeline, routed south to SSWD via Walerga Road, has been identified and will be evaluated, as required, during Phase II engineering analysis.

Table C-6
Opinion of Capital Cost for Sankey Diversion Alternative

(Estimate does not include costs for easements, land purchase, or future advanced oxidation processes.)

Description	Unit	Quantity	Cost	Extended Cost
ELKHORN/ELVERTA INTAKE STRUCTURE AND RAW WATER CONVEYANCE PIPELINES				
Sacramento River Intake Structure at Elverta Rd	ls	1	$ 25,600,000	$ 25,600,000
RW Conveyance Pipelines (dual 66" dia.)	lf	9,600	$ 594	$ 5,703,000
Subtotal				**$ 31,303,000**
WATER TREATMENT FACILITY ON ELVERTA ROAD[1]				
Grit Basin and Flash Mix Structure	mgd	165	$ 65,000	$ 10,725,000
Flocculation/Sedimentation Basins	mgd	165	$ 130,000	$ 21,450,000
Filters	mgd	165	$ 165,000	$ 27,225,000
Waste Washwater Equalization System	mg	1	$ 2,000,000	$ 2,000,000
Chemical Systems	ls	1	$ 2,250,000	$ 2,250,000
Chemical Building(1)	ls	1	$ 2,600,000	$ 2,600,000
Operations/Administration Building	ls	1	$ 2,250,000	$ 2,250,000
Sludge Lagoons	sf	200,000	$ 14	$ 2,800,000
C*T Tank	mg	1.7	$ 1,200,000	$ 2,040,000
Treated Water Reservoir (Clearwell)	mg	17	$ 750,000	$ 12,750,000
Treated Water Pump Station	hp	8,000	$ 1,500	$ 12,000,000
Yard Piping	ls	1	$ 2,200,000	$ 2,200,000
Site Work and Landscaping	ls	1	$ 1,500,000	$ 1,500,000
Electrical, Instrumentation, and Controls	ls	1	$ 12,000,000	$ 12,000,000
Subtotal				**$ 113,790,000**
ELKHORN/ELVERTA TREATED WATER CONVEYANCE PIPELINES				
TW Conveyance Pipeline (96" dia.)	lf	42,000	$ 864	$ 36,288,000
Subtotal				**$ 36,288,000**
SANKEY INTAKE STRUCTURE AND RAW WATER CONVEYANCE PIPELINES				
Sacramento River Intake Structure at Sankey Rd	ls	1	$ 16,650,000	$ 16,650,000
RW Conveyance Pipelines (72" dia.)	lf	42,500	$ 648	$ 27,540,000
Subtotal				**$ 44,190,000**

Table C-6 (continued)

Description	Unit	Quantity	Cost	Extended Cost
WATER TREATMENT FACILITY ON SANKEY ROAD				
Grit Basin and Flash Mix Structure	mgd	90	$ 70,000	$ 6,300,000
Flocculation/Sedimentation Basins	mgd	90	$ 135,000	$ 12,150,000
Filters	mgd	90	$ 170,000	$ 15,300,000
Waste Washwater Equalization System	mg	1	$ 1,300,000	$ 1,300,000
Chemical Systems	ls	1	$ 1,500,000	$ 1,500,000
Chemical Building	ls	1	$ 1,500,000	$ 1,500,000
Operations/Administration Building	ls	1	$ 1,500,000	$ 1,500,000
Sludge Lagoons	sf	150,000	$ 14	$ 2,100,000
C*T Tank	mg	1	$ 1,200,000	$ 1,200,000
Treated Water Reservoir (Clearwell)	mg	9	$ 850,000	$ 7,650,000
Treated Water Pump Station	hp	5,500	$ 1,500	$ 8,250,000
Yard Piping	ls	1	$ 2,000,000	$ 2,000,000
Site Work and Landscaping	ls	1	$ 1,250,000	$ 1,250,000
Electrical, Instrumentation, and Controls	ls	1	$ 9,000,000	$ 9,000,000
Subtotal				**$ 71,000,000**
SANKEY TREATED WATER CONVEYANCE PIPELINES				
TW Conveyance Pipeline (72" dia.)	lf	32,000	$ 648	$ 20,736,000
TW Conveyance Pipeline (66" dia.)	lf	20,000	$ 594	$ 11,880,000
TW Conveyance Pipeline (48" dia.)	lf	46,000	$ 432	$ 19,872,000
Roseville Fluoridation Dosing Station	ls	1	$ 150,000	$ 150,000
Subtotal				**$ 52,638,000**
Sankey Diversion Alternative (All Facilities) Opinion of Cost Subtotal				**$ 349,209,000**
Engineering, Environmental, Administration, and Legal Services	30%			$ 104,770,000
Subtotal				**$ 453,980,000**
Contingency	25%			$ 113,500,000
OPINION OF TOTAL CAPITAL COST				**$ 567,500,000**

[1] Includes Sacramento's Fluoridation Dosing Station

Key:

C*T	disinfection contact time	mg	million gallons
dia.	diameter	mgd	million gallons per day
hp	horsepower	RW	raw water
lf	linear feet	sf	square feet
ls	lump sum	TW	treated water

FEATHER RIVER DIVERSION ALTERNATIVE

The elements of this alternative are depicted in **Figures C-7 through C-9** and summarized in **Table C-7. Figure C-7** shows an overview of the project while **Figures C-8 and C-9** show details of intake facilities and water treatment facilities, respectively. The Feather River Diversion Alternative includes two raw water intakes and associated pump stations, one located on the Feather River and one on the Sacramento River, two WTPs, raw water pipelines, and treated water pipelines (see **Figure C-7**). This alternative would provide water supply for Sacramento from a new 165 mgd separate diversion and WTP drawing from the Sacramento River, while PCWA, Roseville, and SSWD would obtain water from a new 90-mgd joint diversion and joint treatment plant drawing from the Feather River.

Diversion Facilities and Raw Water Conveyance Pipelines

Diversion facilities and pipelines for the Sacramento portion and the PCWA, Roseville, and SSWD portion of this alternative are described below.

Sacramento Portion

The Sacramento portion of diversion facilities and raw water conveyance pipelines for the Feather River Diversion alternative is shown **Figure C-8** and in **Figure C-B2** in Attachment B. The Sacramento portion would be identical to that previously described in the Sankey Diversion alternative.

PCWA, Roseville, and SSWD Portion

The proposed intake facility, which would serve PCWA, Roseville, and SSWD, would be located on the Feather River near the southwest end of the town of Nicolaus. The site investigation area included an approximately 3-mile stretch of the river beginning immediately northeast of the Highway 99 bridge and continuing northeast, as generally identified in the **Appendix B** of the main report. The proposed site, located approximately at river mile 9.6, is presented in **Figure C-8**. Locating the intake downstream of the Highway 99 bridge was considered but rejected. A downstream location would have required tunneling under Highway 99, with associated cost and complexity, and would have subjected the intake to greater backwater effects from the Sacramento River.

The 90-percent exceedence water surface elevation at the proposed site was approximately 14.0 feet. With a river bottom elevation of approximately 10.0 feet, the available water depth at the site would be 4.0 feet. The intake would be approximately 119 feet long, with length governed by available river depth at this site (see **Figure C-B4** in Attachment B). The area of land on the river side of the levee that would be affected by intake construction is approximately 3.5 acres.

There is no existing development at or adjacent to the proposed intake site within the river side of the levee. Property ownership for the site has not yet been determined but it is assumed that the land is privately owned.

Water would exit the intake facility via a single 72-inch diameter pipeline and be pumped to the proposed WTP approximately 8 miles east along Nicolaus Avenue. A pumping head of approximately 90 feet would be required to convey the 90-mgd flow.

Table C-7
Inventory of Required Facilities for the Feather River Alternative

DIVERSION FACILITIES			
Capacity (mgd)	**Location**	**Description/Notes**	**Cost-Sharing Partners Served**
90	Feather River – near the town of Nicolaus	New intake facility, approximately 3.5 acres	PCWA, SSWD, Roseville
165	Sacramento River – Garden Hwy near Elverta Rd	New intake facility, approximately 1.3 acres	Sacramento

WATER TREATMENT FACILITIES			
Capacity (mgd)	**Location**	**Description/Notes**	**Cost-Sharing Partners Served**
90	Intersection of Nicolaus Ave and Brewer Rd	New WTP, approximately 40 acres	PCWA, SSWD, Roseville
165	On Elverta Rd approximately 1 mile east of Garden Hwy	New WTP, approximately 70 acres	City of Sacramento

RAW WATER CONVEYANCE PIPELINES						
Pipeline Segment Start	**Pipeline Segment End**	**Description/Notes**	**Max Flow Rate (mgd)**	**Maximum Diameter (inches)**	**Approximate Length (miles)**	**Cost-Sharing Partners Served**
Feather River at Nicolaus Intake Facility	Nicolaus Ave/Brewer Rd WTP	Under levee, Nicolaus Rd to Brewer Rd	90	72	8	PCWA, SSWD, Roseville
Garden Hwy/Elverta Rd Intake Facility	Elverta Rd/Garden Hwy WTP	Under levee, under agricultural fields	165	Dual 66	1.0	Sacramento

TREATED WATER CONVEYANCE PIPELINES						
Pipeline Segment Start	**Pipeline Segment End**	**Description/Notes**	**Max Flow Rate (mgd)**	**Maximum Diameter (inches)**	**Approximate Length (miles)**	**Cost-Sharing Partners Served**
Nicolaus Ave/Brewer Rd WTP	Intersection of Fiddyment Rd and Athens Rd	First section of pipeline carries flow from the three affected cost-sharing partners	90	72	9.8	SSWD, Roseville, PCWA
Intersection of Fiddyment Rd and Athens Rd	Intersection of Fiddyment Rd and Blue Oaks Blvd	Pipeline routed via Fiddyment Rd to Roseville tie-in	39	48	3.8	SSWD, Roseville, PCWA
Intersection of Fiddyment Rd and Blue Oaks Blvd	Intersection of Baseline Rd and Fiddyment Rd	Pipeline routed via Fiddyment Rd to PCWA tie-in	29	48	2.8	SSWD, PCWA
Intersection of Baseline Rd and Fiddyment Rd	Intersection of Antelope Rd and Walerga Rd	Connect to 48-inch Cooperative Transmission Pipeline/Northridge Transmission Pipeline	15	48	5.9	SSWD
Elverta Rd/Garden Hwy WTP	Intersection of East Drainage Canal and Del Paso Rd	Routed south parallel to East Drainage Canal to Del Paso Rd	165	96	8.0	Sacramento

Water Treatment Facilities

Water treatment facilities and pipelines for the Sacramento portion and the PCWA, Roseville, and SSWD portion of this alternative are described below

Sacramento Portion

The Sacramento portion of water treatment facilities for the Feather River Diversion alternative is shown **Figure C-9**. The Sacramento portion would be identical to that previously described in the Sankey Diversion alternative.

PCWA, Roseville, and SSWD Portion

The proposed site for the 90 mgd WTP is shown in **Figure C-9**. The site is located approximately 8 miles east of the town of Nicolaus, on Nicolaus Avenue at its intersection with Brewer Road. The terrain of the proposed site is flat, approximately 40 acres in area, and currently used for farming.

Raw water would enter the site from the west via a 72-inch pipeline. Treated water would exit the site towards the east via a 72-inch pipeline that would serve PCWA, Roseville, and SSWD.

As with the Sacramento site, facilities would comprise conventional treatment processes, including a grit basin, floc/sed basins, filters, C*T tank, clearwell, backwash water basin, electrical building, chemical building, operations building, solids handling area, and storm water detention/habitat conservation program area. In addition, physical and hydraulic space was reserved for an AOP, such as ozone or UV light, which would accommodate future drinking water regulations. A high-service pump station was also included for moving treated water to the distribution system.

Treated Water Conveyance Pipelines

The Feather River Diversion Alternative treated water pipeline follows two alignments: one alignment would lead to Sacramento from the Elverta Road WTP and the other to PCWA, Roseville, and SSWD from the Nicolaus Road WTP. Routes described below are described below (see **Figure C-7**).

Sacramento Portion

The treated water pipeline alignment and capacity are identical to those for the Elkhorn/Elverta Diversion Alternative.

PCWA, Roseville, and SSWD Portion

- From the Nicolaus Avenue WTP, a 72-inch diameter pipeline would head east for approximately 5.7 miles following Nicolaus Avenue.
- The 72-inch pipeline would turn south for 2 miles through agricultural fields to Fiddyment Road.
- The 72-inch pipeline would continue south along Fiddyment Road for approximately 2 miles to the PCWA tie-in point at Fiddyment Road and Athens Road.
- A 48-inch diameter pipeline would continue 3.7 miles south along Fiddyment Road to the tie-in point for Roseville at Fiddyment Road and Blue Oaks Boulevard.
- A 48-inch pipeline would continue south on Fiddyment Road for 2.8 miles to the PCWA (Placer Vineyards) tie-in point at Fiddyment Road and Baseline Road.

- The 48-inch pipeline then would turn west on Baseline Road for approximately 1.8 miles.[13]
- The 48-inch pipeline then would turn south on Watt Avenue for approximately 3.6 miles to Antelope Road.
- At Antelope Road, the 48-inch pipeline would then proceed to Walerga Road to the SSWD tie-in (connecting to the CTP).

Opinion of Cost

A cost breakdown for the Feather River Diversion alternative is presented in **Table C-8**. The opinion of total capital cost for all facilities, including costs for engineering, environmental, administration, and legal services, and a 25-percent contingency is $583,600,000.

The overall O&M costs for this alternative are expected to be the highest of all alternatives. The diversion, treatment, and pumping costs are expected to be the greatest, while pipeline O&M costs are expected to be near average. **Attachment A** provides a summary of the assessment.

[13] An alternative alignment for the remainder of this pipeline, routed south to SSWD via Walerga Road, has been identified and will be evaluated, as required, during Phase II engineering analysis.

Table C-8
Opinion of Capital Cost for Feather River Diversion Alternative

(Estimate does not include costs for easements, land purchase, or future advanced oxidation processes.)

Description	Unit	Quantity	Cost	Extended Cost
ELKHORN/ELVERTA INTAKE STRUCTURE AND RAW WATER CONVEYANCE PIPELINES				
Sacramento River Intake Structure at Elverta Rd	ls	1	$ 25,600,000	$ 25,600,000
RW Conveyance Pipelines (dual 66" dia.)	lf	9,600	$ 594	$ 5,702,000
Subtotal				**$ 31,302,000**
WATER TREATMENT FACILITY ON ELVERTA ROAD[1]				
Grit Basin and Flash Mix Structure	mgd	165	$ 65,000	$ 10,725,000
Flocculation/Sedimentation Basins	mgd	165	$ 130,000	$ 21,450,000
Filters	mgd	165	$ 165,000	$ 27,225,000
Waste Washwater Equalization System	mg	1	$ 2,000,000	$ 2,000,000
Chemical Systems	ls	1	$ 2,250,000	$ 2,250,000
Chemical Building(1)	ls	1	$ 2,600,000	$ 2,600,000
Operations/Administration Building	ls	1	$ 2,250,000	$ 2,250,000
Sludge Lagoons	sf	200,000	$ 14	$ 2,800,000
C*T Tank	mg	1.7	$ 1,200,000	$ 2,040,000
Treated Water Reservoir (Clearwell)	mg	17	$ 750,000	$ 12,750,000
Treated Water Pump Station	hp	8,000	$ 1,500	$ 12,000,000
Yard Piping	ls	1	$ 2,200,000	$ 2,200,000
Site Work and Landscaping	ls	1	$ 1,500,000	$ 1,500,000
Electrical, Instrumentation, and Controls	ls	1	$ 12,000,000	$ 12,000,000
Subtotal				**$ 113,790,000**
ELKHORN/ELVERTA TREATED WATER CONVEYANCE PIPELINES				
TW Conveyance Pipeline (96" dia.)	lf	42,000	$ 864	$ 36,288,000
Subtotal				**$ 36,288,000**
FEATHER RIVER INTAKE STRUCTURE AND RAW WATER CONVEYANCE PIPELINES				
Feather River Intake Structure	ls	1	$ 17,550,000	$ 17,550,000
RW Conveyance Pipelines (72" dia.)	lf	42,000	$ 648	$ 27,216,000
Subtotal				**$ 44,766,000**

Table C-8 (continued)

Description	Unit	Quantity	Cost	Extended Cost
WATER TREATMENT FACILITY ON NICOLAUS ROAD				
Grit Basin and Flash Mix Structure	mgd	90	$ 70,000	$ 6,300,000
Flocculation/Sedimentation Basins	mgd	90	$ 135,000	$ 12,150,000
Filters	mgd	90	$ 170,000	$ 15,300,000
Waste Washwater Equalization System	mg	1	$ 1,300,000	$ 1,300,000
Chemical Systems	ls	1	$ 1,500,000	$ 1,500,000
Chemical Building	ls	1	$ 1,500,000	$ 1,500,000
Operations/Administration Building	ls	1	$ 1,500,000	$ 1,500,000
Sludge Lagoons	sf	150,000	$ 14	$ 2,100,000
C*T Tank	mg	1	$ 1,200,000	$ 1,200,000
Treated Water Reservoir (Clearwell)	mg	9	$ 850,000	$ 7,650,000
Treated Water Pump Station	hp	5,500	$ 1,500	$ 8,250,000
Yard Piping	ls	1	$ 2,000,000	$ 2,000,000
Site Work and Landscaping	ls	1	$ 1,250,000	$ 1,250,000
Electrical, Instrumentation, and Controls	ls	1	$ 9,000,000	$ 9,000,000
Subtotal				**$ 71,000,000**
FEATHER RIVER TREATED WATER CONVEYANCE PIPELINES				
TW Conveyance Pipeline (72" dia.)	lf	51,500	$ 648	$ 33,372,000
TW Conveyance Pipeline (48" dia.)	lf	65,800	$ 432	$ 28,426,000
Roseville Fluoridation Dosing Station	ls	1	$ 150,000	$ 150,000
Subtotal				**$ 61,948,000**
Feather River Diversion Alternative (All Facilities) Opinion of Cost Subtotal				**$ 359,094,000**
Engineering, Environmental, Administration, and Legal Services	30%			$ 107,730,000
Subtotal				**$ 466,830,000**
Contingency	25%			$ 116,710,000
OPINION OF TOTAL CAPITAL COST				**$ 583,600,000**

[1] Includes Sacramento's Fluoridation Dosing Station

Key:

C*T	disinfection contact time	mg	million gallons
dia.	diameter	mgd	million gallons per day
hp	horsepower	RW	raw water
lf	linear feet	sf	square feet
ls	lump sum	TW	treated water

AMERICAN RIVER PUMP STATION ALTERNATIVE

Elements of this alternative are depicted in **Figures C-10 through C-12** and summarized in **Table C-9**. **Figure C-10** shows an overview of the project while **Figures C-11 and C-12** show details of intake facilities and water treatment facilities, respectively. The ARPS alternative includes expanding the intake pumping capacity of PCWA's ARPS, and constructing a new raw water intake and associated pump station located on the Sacramento River. The alternative also includes expanding the capacity of the Auburn Tunnel Pump Station (ATPS), expanding the planned Foothill Phase II WTP, and constructing a new WTP near the proposed Sacramento River intake. In addition, the alternative includes a raw water pipeline and treated water pipelines (see **Figure C-10**). This alternative would provide water supply for Sacramento from the new 165 mgd diversion while PCWA would obtain 65 mgd from expanded American River facilities. Roseville would meet its demands through increased groundwater pumping, and SSWD would meet its demands through the use of shoulder capacity from SJWD's Peterson WTP.

Diversion Facilities and Raw Water Conveyance Pipelines

Diversion facilities and new water conveyance pipelines for each of the cost-sharing partners for this alternative are described below.

Sacramento Portion

The Sacramento portion of diversion facilities and raw water conveyance pipelines for the ARPS alternative is shown **Figure C-11** and in **Figure C-B2** in Attachment B. The Sacramento portion would be identical to that previously described in the Sankey Diversion alternative.

PCWA Portion

Expanding the pumping capacity of PCWA's ARPS and the capacity of ATPS is included in the current alternative. Pumping capacity would increase by 65 mgd, with the increased flow directed into the existing Auburn Ravine Tunnel. The capacity of ARPS would be increased by upgrading and modifying two existing motors and pumps, providing one new motor and pump, modifying discharge piping, providing upgraded power transformers, and modifying the fish screen airburst system. The footprint of ARPS would not increased and no modifications to the structure would be required. Likewise, ATPS would be modified for this alternative to increase its capacity by 100 cubic feet per second (cfs). The ARPS site is shown in **Figure C-11**.

Roseville Portion

The Roseville portion of the ARPS alternative would entail additional groundwater pumping. Capital costs for four additional groundwater pumping and treatment points have been included in the opinion of costs.

SSWD Portion

The SSWD portion of the ARPS alternative entails using shoulder capacity from SJWD's Peterson WTP, located adjacent to Folsom Lake. No capital costs for the SSWD portion have been included in the opinion of costs.

Water Treatment Facilities

Water treatment facilities for each of the cost-sharing partners for this alternative are described below.

Table C-9
Inventory of Required Facilities for the American River Pump Station Alternative[1]

DIVERSION FACILITIES			
Capacity (mgd)	**Location**	**Description/Notes**	**Cost-Sharing Partners Served**
65	ARPS and Auburn Tunnel Pump Station	Expansion of existing pumping capacities	PCWA
165	Sacramento River – Garden Hwy near Elverta Rd	New intake facility, approximately 1.3 acres	Sacramento

WATER TREATMENT FACILITIES			
Capacity (mgd)	**Location**	**Description/Notes**	**Cost-Sharing Partners Served**
65	Ophir Rd at existing Auburn Tunnel Pump Station site	65 mgd expansion of proposed 30 mgd WTP approximately 6 acres	PCWA
165	On Elverta Rd approximately 1 mile east of Garden Hwy	New WTP, approximately 70 acres	Sacramento

RAW WATER CONVEYANCE PIPELINES[2]						
Pipeline Segment Start	**Pipeline Segment End**	**Description/Notes**	**Max Flow Rate (mgd)**	**Maximum Diameter (inches)**	**Approximate Length (miles)**	**Cost-Sharing Partners Served**
Garden Hwy/Elverta Rd Intake Facility	Elverta Rd/Garden Hwy WTP	Over levee, under agricultural fields	165	Dual 66	1.0	Sacramento

TREATED WATER CONVEYANCE PIPELINES						
Pipeline Segment Start	**Pipeline Segment End**	**Description/Notes**	**Max Flow Rate (mgd)**	**Maximum Diameter (inches)**	**Approximate Length (miles)**	**Cost-Sharing Partners Served**
Expanded Auburn Ravine WTP	Intersection of Athens Rd and Fiddyment Rd	Follows Ophir Rd and Taylor Rd and parallels existing English Col. Way alignment to Sunset Tank, cross-country to Fiddyment Rd/Athens Rd	65	60	15.8	PCWA
Intersection of Athens Rd and Fiddyment Rd	Intersection of Fiddyment Rd and Baseline Rd	Pipeline routed via Fiddyment Rd to PCWA tie-in	14	30	6.6	PCWA
Elverta Rd/Garden Hwy WTP	Intersection East Drainage Canal and Del Paso Rd	Routed south parallel to East Drainage Canal to Del Paso Rd	165	96	8.0	Sacramento

[1] For this alternative: Roseville would increase groundwater use, SSWD would use shoulder capacity from SJWD.
[2] Raw water to PCWA WTP conveyed through Auburn Ravine Tunnel.

Sacramento Portion

The Sacramento portion of water treatment facilities for the ARPS alternative is shown **Figure C-12**. The Sacramento portion would be identical to that previously described in the Sankey Diversion alternative.

PCWA Portion

The proposed 65 mgd expansion of the planned Foothill Phase II WTP is shown in **Figure C-12**. The site is located approximately adjacent to the Auburn Wastewater Treatment Facility on Ophir Road at its intersection with Hillbrook Road. The expansion construction would affect approximately 6 acres at the planned WTP site.

A site development evaluation report was prepared by Black & Veatch.[14] It was assumed that raw water would be pumped vertically from the Auburn Tunnel to the WTP by ATPS, which is currently being expanded. Facility capacity would expand from 60 to 125 mgd and would include new flash mix, sedimentation facilities, filters, a backwash basin, sludge thickener, potentially UV disinfection, and a 5-million-gallon clearwell. Additional pumping capacity would also be required. Treated water would exit the site towards the west via a 60-inch pipeline that would serve PCWA.

Roseville Portion

The Roseville portion of the ARPS alternative would entail additional groundwater pumping. Capital costs for four additional groundwater pumping and treatment points have been included in the opinion of costs.

SSWD Portion

The SSWD portion of the ARPS alternative would entail using shoulder capacity from SJWD's Peterson WTP, located adjacent to Folsom Lake. No capital costs for the SSWD portion have been included in the opinion of costs.

Treated Water Conveyance Pipelines

The ARPS alternative treated water pipeline would follow two alignments: one alignment would lead to Sacramento from the Elverta Road WTP and the other to PCWA from the Ophir Road WTP. Routes are described below (see **Figure C-10**).

Sacramento Portion

The treated water pipeline alignment and capacity would be identical to those in the Elkhorn/Elverta Diversion Alternative.

PCWA Portion

- From the Ophir Road WTP, a 60-inch diameter pipeline would head south for approximately 4.7 miles along Ophir/Taylor Road to English Colony Way.[15]

[14] Black & Veatch. 2003. Foothill Phase II Water Treatment Plant Initial Planning and Siting Study - Site Development Evaluation. Draft Memorandum. August.

[15] An alternative alignment for PCWA's pipeline has been identified ("Southern Alignment") and will be incorporated into the Phase II engineering analysis.

- The 60-inch pipeline would turn west on English Colony Way paralleling the existing 24-inch pipeline on English Colony Way/Del Mar Avenue for 3 miles.
- The 60-inch pipeline then would continue 0.5 miles south on Sierra College Boulevard.
- The 60-inch pipeline then would parallel north Clover Valley Road for approximately 0.25 miles.
- The 60-inch pipeline would turn south for approximately 0.75 miles to the PCWA Sunset Tank.
- From the PCWA Sunset Tank, the 60-inch pipeline would turn west and continue cross-country for approximately 6.5 miles to the PCWA tie-in point at Athens Road and Fiddyment Road.
- A 30-inch diameter pipeline would follow Fiddyment Road south for 6.6 miles to the PCWA (Placer Vineyards) tie-in point at Fiddyment Road and Baseline Road.

Roseville and SSWD Portions

No treated water pipeline facilities would be included for Roseville and SSWD in the ARPS alternative.

Opinion of Cost

A cost breakdown for the ARPS alternative is presented in **Table C-10**. The opinion of total capital cost for all facilities, including costs for engineering, environmental, administration, and legal services, and a 25-percent contingency is $482,268,000.

The overall O&M costs for this alternative are expected to be lower than for most alternatives. Diversion facilities are expected to have higher than average O&M costs, and treatment and pumping facilities are expected to have lower than average O&M costs, while pipeline O&M would likely be near average. Attachment A provides a summary of the assessment.

Table C-10
Opinion of Capital Cost for American River Pump Station Alternative

(Estimate does not include costs for easements, land purchase, or future advanced oxidation processes.)

Description	Unit	Quantity	Cost	Extended Cost
ELKHORN/ELVERTA INTAKE STRUCTURE AND RAW WATER CONVEYANCE PIPELINES				
Sacramento River Intake Structure at Elverta Rd.	ls	1	$ 25,600,000	$ 25,600,000
RW Conveyance Pipelines (dual 66" dia.)	lf	9,600	$ 594	$ 5,702,000
Subtotal				**$ 31,302,000**
WATER TREATMENT FACILITY PLANT ON ELVERTA ROAD[1]				
Grit Basin and Flash Mix Structure	mgd	165	$ 65,000	$ 10,725,000
Flocculation/Sedimentation Basins	mgd	165	$ 130,000	$ 21,450,000
Filters	mgd	165	$ 165,000	$ 27,225,000
Waste Washwater Equalization System	mg	1	$ 2,000,000	$ 2,000,000
Chemical Systems	ls	1	$ 2,250,000	$ 2,250,000
Chemical Building(1)	ls	1	$ 2,600,000	$ 2,600,000
Operations/Administration Building	ls	1	$ 2,250,000	$ 2,250,000
Sludge Lagoons	sf	200,000	$ 14	$ 2,800,000
C*T Tank	mg	1.7	$ 1,200,000	$ 2,040,000
Treated Water Reservoir (Clearwell)	mg	17	$ 750,000	$ 12,750,000
Treated Water Pump Station	hp	8,000	$ 1,500	$ 12,000,000
Yard Piping	ls	1	$ 2,200,000	$ 2,200,000
Site Work and Landscaping	ls	1	$ 1,500,000	$ 1,500,000
Electrical, Instrumentation, and Controls	ls	1	$ 12,000,000	$ 12,000,000
Subtotal				**$ 113,790,000**
ELKHORN/ELVERTA TREATED WATER CONVEYANCE PIPELINES				
TW Conveyance Pipeline (96" dia.)	lf	42,000	$ 864	$ 36,288,000
Subtotal				**$ 36,288,000**
ARPS RAW WATER FACILITIES AND CONVEYANCE PIPELINES				
ARPS Modifications	ls	1	$ 1,700,000	$ 1,700,000
ATPS Modifications	ls	1	$ 1,500,000	$ 1,500,000
Subtotal				**$ 3,200,000**
WATER TREATMENT FACILITY ON OPHIR ROAD				
Flash Mix Structure	ls	1	$ 1,000,000	$ 1,000,000
Sedimentation Facilities (Actiflo)	ls	1	$ 9,000,000	$ 9,000,000
Filters	ls	1	$ 10,500,000	$ 10,500,000
Backwash Recovery System	ls	1	$ 3,900,000	$ 3,900,000
Solids Handling	ls	1	$ 5,700,000	$ 5,700,000
Chemical Feed Systems	ls	1	$ 1,500,000	$ 1,500,000
Site Work	ls	1	$ 3,000,000	$ 3,000,000
Electrical and Instrumentation	ls	1	$ 4,000,000	$ 4,000,000
Treated Water Reservoir (Clearwell)	mg	5	$ 750,000	$ 3,750,000
Treated Water Pump Station Modifications	ls	1	$ 1,800,000	$ 1,800,000
Subtotal				**$ 44,150,000**

Table C-10 (continued)

Description	Unit	Quantity	Cost	Extended Cost
ARPS TREATED WATER CONVEYANCE PIPELINES				
TW Conveyance Pipeline (60" dia.)	lf	83,000	$ 600	$ 49,800,000
TW Conveyance Pipeline (30" dia.)	lf	35,000	$ 270	$ 9,450,000
Subtotal				**$ 59,250,000**
GROUNDWATER WELLS AND TREATMENT FACILITIES (ROSEVILLE)				
1,750 gpm Groundwater Well and Treatment	ea	4	$ 2,200,000	$ 8,800,000
Subtotal				**$ 8,800,000**
American River Pump Station Alternative (All Facilities) Opinion of Cost Subtotal				**$ 296,780,000**
Engineering, Environmental, Administration, and Legal Services	30%			$ 89,034,000
Subtotal				**$ 385,814,000**
Contingency	25%			$ 96,454,000
OPINION OF TOTAL CAPITAL COST				**$ 482,268,000**

[1] Includes Sacramento's Fluoridation Dosing Station

Key:

C*T	disinfection contact time	ls	lump sum
dia.	diameter	mg	million gallons
ea	each	mgd	million gallons per day
gpm	gallons per minute	RW	raw water
hp	horsepower	sf	square feet
lf	linear feet	TW	treated water

FOLSOM DAM ALTERNATIVE

Elements of this alternative are depicted in **Figures C-13 through C-15** and summarized in **Table C-11**. **Figure C-13** shows an overview of the project while **Figures C-14 and C-15** show details of intake facilities and water treatment facilities, respectively. The Folsom Dam alternative includes constructing a tie-in to the existing Folsom Dam penstocks, a new raw water pump station, and a new raw water intake and associated pump station located on the Sacramento River. The alternative also includes expanding SJWD's Peterson WTP and constructing a new WTP near the proposed Sacramento River intake. In addition, the alternative includes raw water pipelines and treated water pipelines (see **Figure C-13**). This alternative would provide water supply for Sacramento from the new 165 mgd diversion, while PCWA would obtain 65 mgd from the new penstock connection and expanded SJWD Peterson WTP facilities. Roseville would meet its demands through increased groundwater pumping, and SSWD would meet its demands through the use of shoulder capacity from SJWD's expanded Peterson WTP.

Diversion Facilities and Raw Water Conveyance Pipelines

Diversion facilities and raw water conveyance pipelines for each of the cost-sharing partners are described below for this alternative.

Sacramento Portion

The Sacramento portion of diversion facilities and raw water conveyance pipelines for the Folsom Dam alternative is shown in **Figure C-14** and in **Figure C-B2** in Attachment B. The Sacramento portion would be identical to that previously described in the Sankey Diversion alternative.

PCWA Portion

The penstock tie-in approach for the Folsom Dam alternative follows from the design developed for USACE's Redundant Water Supply, Folsom Dam, California, Appraisal Study Report.[16] The study considered seven alternatives for constructing a redundant water supply at Folsom Dam, and ranked tapping into the existing penstocks the highest. Significantly, the report eliminated the alternative that proposed a new freestanding intake structure, primarily due to the expected high cost of construction. While the report had different goals than the current project, the concept of tapping into the penstocks would be equally valid and will be pursued further. Significant coordination with the Reclamation, would be required for this alternative. Potential loss of power generation capabilities due to the diversion from the penstocks may have a significant impact on the project. The Folsom Dam tie-in location is shown in **Figure C-14** and would consist of tapping into the top of penstocks no. 1 and no. 2 between the toe of the gravity dam and the tunnel leading to the powerhouse with a 60-inch diameter pipeline. Water would be conveyed from the tie-in via a 60-inch pipe through a new booster pump station located west of the existing pump station. From the pump station, the 60-inch pipe would parallel the existing 84-inch pipe to the expanded Peterson WTP.

[16] MWH. 2003. Redundant Water Supply, Folsom Dam, California, Appraisal Study Report. For USACE. January.

Table C-11
Inventory of Required Facilities for the Folsom Dam Alternative[1]

DIVERSION FACILITIES			
Capacity (mgd)	**Location**	**Description/Notes**	**Cost-Sharing Partners Served**
65	Folsom Dam	Tap into existing penstock, new low lift pump station, if required	PCWA
165	Sacramento River – Garden Hwy near Elverta Rd	New intake facility, approximately 1.3 acres	Sacramento

WATER TREATMENT FACILITIES			
Capacity (mgd)	**Location**	**Description/Notes**	**Cost-Sharing Partners Served**
65	SJWD Peterson WTP	65 mgd expansion of existing facility additional 10 acres	PCWA
165	On Elverta Rd approximately 1 mile east of Garden Hwy	New treatment plant, approximately 70 acres	Sacramento

RAW WATER CONVEYANCE PIPELINES						
Pipeline Segment Start	**Pipeline Segment End**	**Description/Notes**	**Max Flow Rate (mgd)**	**Maximum Diameter (inches)**	**Approximate Length (miles)**	**Cost-Sharing Partners Served**
Folsom Dam	SJWD Peterson WTP	Parallels existing 96-inch pipeline	65	60	1.0	PCWA
Garden Hwy/Elverta Rd Intake Facility	Elverta Rd/Garden Hwy WTP	Under levee, under agricultural fields	165	Dual 66	1.0	Sacramento

TREATED WATER CONVEYANCE PIPELINES						
Pipeline Segment Start	**Pipeline Segment End**	**Description/Notes**	**Max Flow Rate (mgd)**	**Maximum Diameter (inches)**	**Approximate Length (miles)**	**Cost-Sharing Partners Served**
SJWD Peterson WTP	Intersection of Baseline Rd and Fiddyment Rd	Parallels Roseville pipeline, to Baseline Rd and Fiddyment Rd	65	60	13.5	PCWA
Intersection of Baseline Rd and Fiddyment Rd	Intersection Fiddyment Rd and Athens Rd	Pipeline routed via Fiddyment Rd to PCWA tie-in	51	54	6.5	PCWA
Elverta Rd/Garden Hwy WTP	Intersection East Drainage Canal and Del Paso Rd	Routed south parallel to East Drainage Canal to Del Paso Rd	165	96	8.0	Sacramento

[1] For this alternative: Roseville would increase groundwater use; SSWD would use shoulder capacity from SJWD.

Roseville Portion

The Roseville portion of the Folsom Dam alternative would entail additional groundwater pumping. Capital costs for four additional groundwater pumping and treatment points have been included in the opinion of costs.

SSWD Portion

The SSWD portion of the Folsom Dam alternative would entail using shoulder capacity from SJWD's Peterson WTP, located adjacent to Folsom Lake. No capital costs for the SSWD portion have been included in the opinion of costs

Water Treatment Facilities

Water treatment facilities for each of the cost-sharing partners are described below for this alternative.

Sacramento Portion

The proposed site for the 165 mgd WTP is identical to the Elkhorn/Elverta Diversion alternative, except that individual treatment processes would be reduced in size to reflect reduced plant capacity. The site is shown in **Figure C-15**. The area required for the proposed site would be reduced to approximately 70 acres. Raw water would enter the site from the west via two 66-inch pipelines and treated water would exit the site towards the east via a 96-inch pipeline that would serve Sacramento.

PCWA Portion

The proposed 65 mgd expansion of SJWD's Peterson WTP is shown in **Figure C-15**. The WTP is located on Auburn-Folsom Road near Northwood Drive. The expansion would impact approximately 10 acres at the existing WTP site.

The preliminary process selection and facility layout was developed by Kennedy-Jenks and is briefly described herein. A 65 mgd expansion of water treatment facilities (from 120 to 185 mgd) would include modifications to the existing flash mix facility, modifications to the existing floc/sed basins, a new parallel floc/sed basin, new filters with backwash facilities, and a new filter backwash and solids-handling facility. The solids-handling facility would comprise of an equalization basin, floc/sed, thickeners, and belt presses resulting in off-site disposal of a dried product. Physical and hydraulic space has been reserved for a pre-ozonation contact basin or post-filtration UV disinfection.

Roseville Portion

The Roseville portion of the Folsom Dam alternative would entail additional groundwater pumping. Capital costs for four additional groundwater pumping and treatment points have been included in the opinion of costs.

SSWD Portion

The SSWD portion of the Folsom Dam alternative would entail using shoulder capacity from SJWD's Peterson WTP, located adjacent to Folsom Lake. No capital costs for the SSWD portion have been included in the opinion of costs.

Treated Water Conveyance Pipelines

The Folsom Dam alternative treated water pipeline follows two alignments: to Sacramento from the Elverta Road WTP and to PCWA from SJWD's Peterson WTP. Routes are described below (see **Figure C-13**).

Sacramento Portion

The treated water pipeline alignment and capacity are identical to those for the Elkhorn/Elverta Diversion alternative.

PCWA Portion

- From SJWD's Peterson WTP, a 60-inch diameter pipeline would be routed northwesterly for approximately 11 miles paralleling the existing Roseville 60-inch diameter pipeline along Auburn-Folsom Road, Barton Road, Roseville Parkway, Cirby Way, across Interstate 80 and railroad, continuing along PFE Road to Cook Riolo Road.

- The 60-inch pipeline would turn north on Cook Riolo Road for approximately 1.6 miles to Baseline Road.

- The 60-inch pipeline would then turn west on Baseline Road for approximately 1 mile to the PCWA (Placer Vineyards) tie-in point on Baseline Road and Fiddyment Road.

- A 54-inch pipeline would continue north on Fiddyment Road for 6.5 miles to the PCWA tie-in point at Fiddyment Road and Athens Road.

Roseville and SSWD Portions

No treated water pipeline facilities would be included for Roseville or SSWD in the Folsom Dam alternative.

Opinion of Cost

A cost breakdown for the Folsom Dam is presented in **Table C-12**. The capital costs to expand SJWD's Peterson WTP were taken from the Kennedy-Jenks report and adjusted to current dollars. The opinion of total capital cost for all facilities, including costs for engineering, environmental, administration, and legal services, and a 25-percent contingency is $483,197,000. It should be noted that any settlement with regard to loss of power generation capacity may add significantly to the overall project cost.

The overall O&M costs for this alternative are expected to be the lowest of all alternatives. The diversion, treatment and pumping facilities are expected to be the least expensive, while pipeline costs are expected to be near average. Attachment A provides a summary of the assessment.

Table C-12
Opinion of Capital Cost for Folsom Dam Alternative

(Estimate does not include costs for easements, land purchase, or future advanced oxidation processes.)

Description	Unit	Quantity	Cost	Extended Cost
ELKHORN/ELVERTA INTAKE STRUCTURE AND RAW WATER CONVEYANCE				
Sacramento River Intake Structure at Elverta Rd	lf	1	$ 25,600,000	$ 25,600,000
RW Conveyance Pipelines (Dual 66" dia.)	lf	9,600	$ 594	$ 5,702,000
Subtotal				**$ 31,302,000**
WATER TREATMENT FACILITY ON ELVERTA ROAD[1]				
Grit Basin and Flash Mix Structure	mgd	165	$ 65,000	$ 10,725,000
Flocculation/Sedimentation Basins	mgd	165	$ 130,000	$ 21,450,000
Filters	mgd	165	$ 165,000	$ 27,225,000
Waste Washwater Equalization System	mg	1	$ 2,000,000	$ 2,000,000
Chemical Systems	ls	1	$ 2,250,000	$ 2,250,000
Chemical Building(1)	ls	1	$ 2,600,000	$ 2,600,000
Operations/Administration Building	ls	1	$ 2,250,000	$ 2,250,000
Sludge Lagoons	sf	200,000	$ 14	$ 2,800,000
C*T Tank	mg	1.7	$ 1,200,000	$ 2,040,000
Treated Water Reservoir (Clearwell)	mg	17	$ 750,000	$ 12,750,000
Treated Water Pump Station	hp	8,000	$ 1,500	$ 12,000,000
Yard Piping	ls	1	$ 2,200,000	$ 2,200,000
Site Work and Landscaping	ls	1	$ 1,500,000	$ 1,500,000
Electrical, Instrumentation, and Controls	ls	1	$ 12,000,000	$ 12,000,000
Subtotal				**$ 113,790,000**
ELKHORN/ELVERTA TREATED WATER CONVEYANCE PIPELINES				
TW Conveyance Pipeline (96" dia.)	lf	42,000	$ 864	$ 36,288,000
Subtotal				**$ 36,288,000**
FOLSOM DAM RAW WATER FACILITIES AND CONVEYANCE PIPELINES				
Interconnect to Penstock	ea	3	$ 250,000	$ 750,000
Reclamation Pump Station at Folsom Dam Mods	hp	2700	$ 1,200	$ 3,240,000
RW Conveyance Pipelines (60" dia.)	lf	5,000	$ 540	$ 2,700,000
Subtotal				**$ 6,690,000**
WATER TREATMENT FACILITY EXPANSION AT SJWD				
Flash Mix	ls	1	$ 728,000	$ 728,000
Floc/Sedimentation Basin Modifications	ls	1	$ 3,780,000	$ 3,780,000
New Flocculation/Sedimentation Basin	ls	1	$ 6,331,000	$ 6,331,000
Filter Modification	ls	1	$ 3,137,000	$ 3,137,000
New Filters	ls	1	$ 6,897,000	$ 6,897,000
Backwash Recovery System	ls	1	$ 3,840,000	$ 3,840,000
Residual Treatment	ls	1	$ 4,652,000	$ 4,652,000
Chemical Feed Systems	ls	1	$ 3,882,000	$ 3,882,000
Site Work	ls	1	$ 2,894,400	$ 2,895,000
Electrical and Instrumentation	ls	1	$ 8,133,000	$ 8,133,000
TW Conveyance Tie-In Modifications	ls	1	$ 1,100,000	$ 1,100,000
Subtotal				**$ 45,375,000**

Table C-12 (continued)

Description	Unit	Quantity	Cost	Extended Cost
FOLSOM DAM TREATED WATER CONVEYANCE PIPELINES				
TW Conveyance Pipeline (60" dia.)	lf	71,000	$ 540	$ 38,340,000
TW Conveyance Pipeline (54" dia.)	lf	34,500	$ 486	$ 16,767,000
Subtotal				**$ 55,107,000**
GROUNDWATER WELLS AND TREATMENT FACILITIES (ROSEVILLE)				
1,750 gpm Groundwater Well and Treatment	ea	4	$ 2,200,000	$ 8,800,000
Subtotal				**$ 8,800,000**
Folsom Dam Alternative (All Facilities) Opinion of Cost Subtotal				**$ 297,352,000**
Engineering, Environmental, Administration, and Legal Services	30%			$ 89,206,000
Subtotal				**$ 386,558,000**
Contingency	25%			$ 96,639,000
OPINION OF TOTAL CAPITAL COST				**$ 483,197,000**

[1] Includes Sacramento's Fluoridation Dosing Station

Key:

C*T	disinfection contact time	ls	lump sum
dia.	diameter	mg	million gallons
ea	each	mgd	million gallons per day
gpm	gallons per minute	RW	raw water
hp	horsepower	sf	square feet
lf	linear feet	TW	treated water

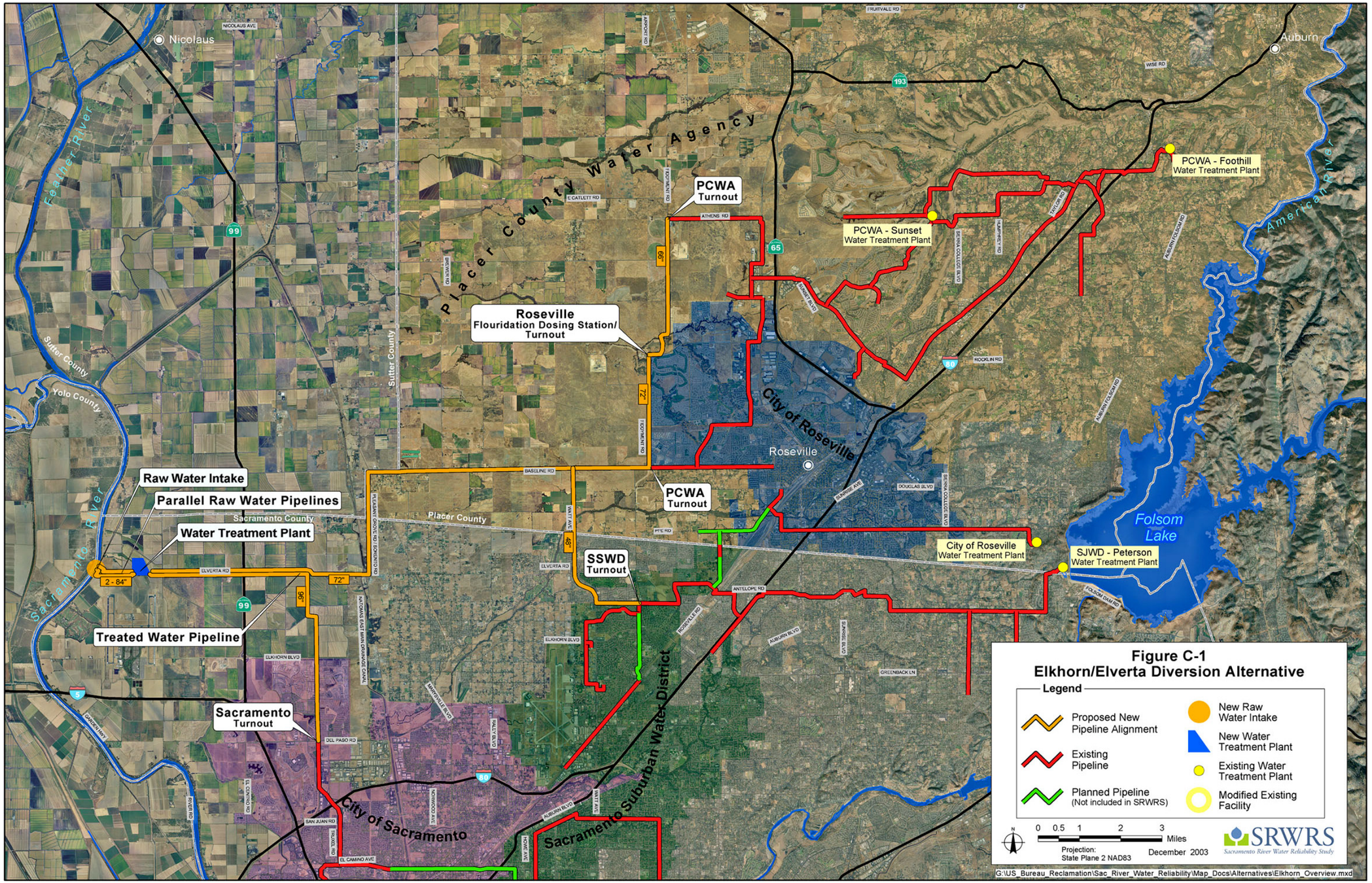


Figure C-1 Elkhorn/Elverta Diversion Alternative

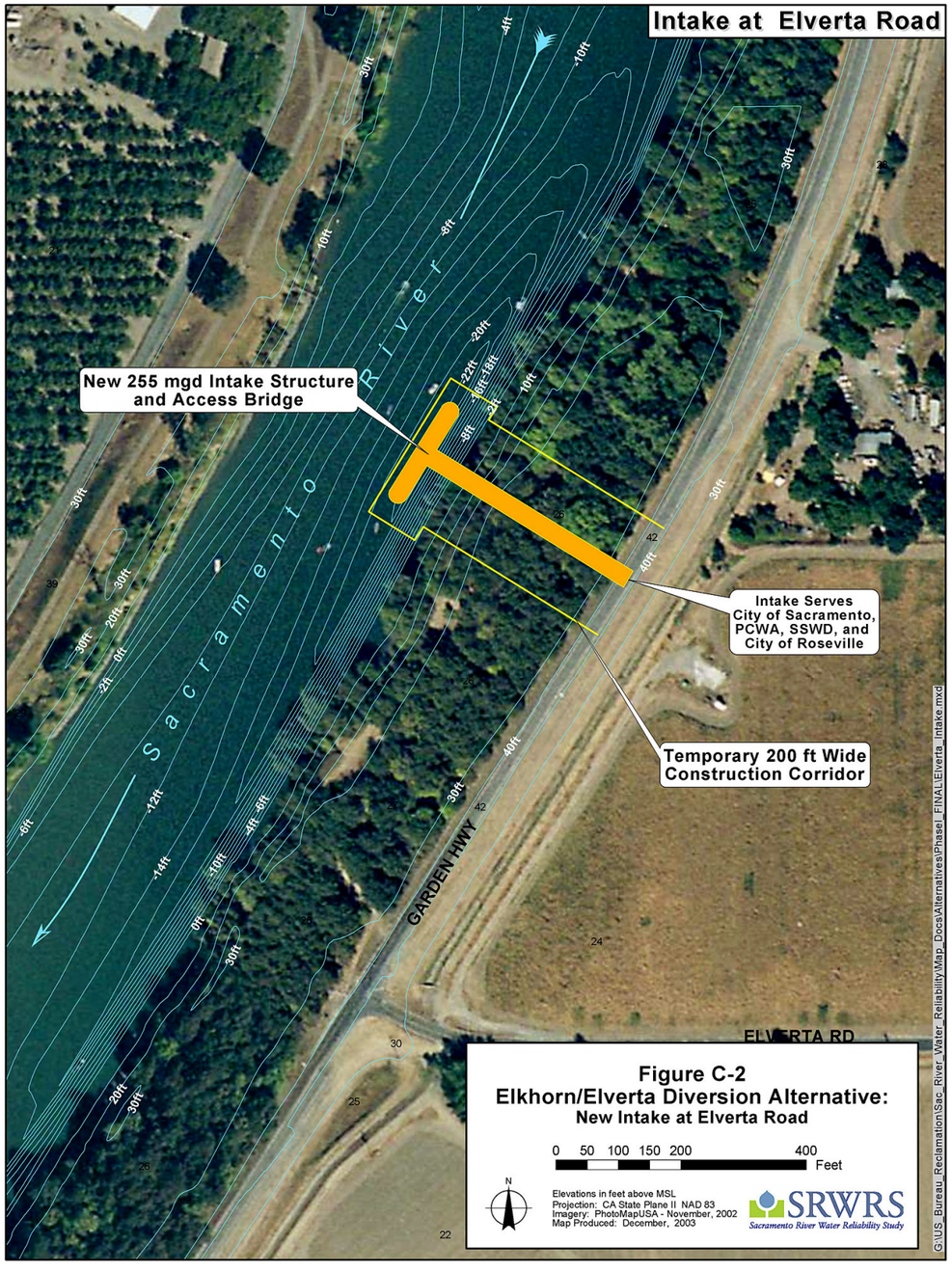


Figure C-2 - Elkhorn/Elverta Diversion Alternative: New intake at Elverta Road

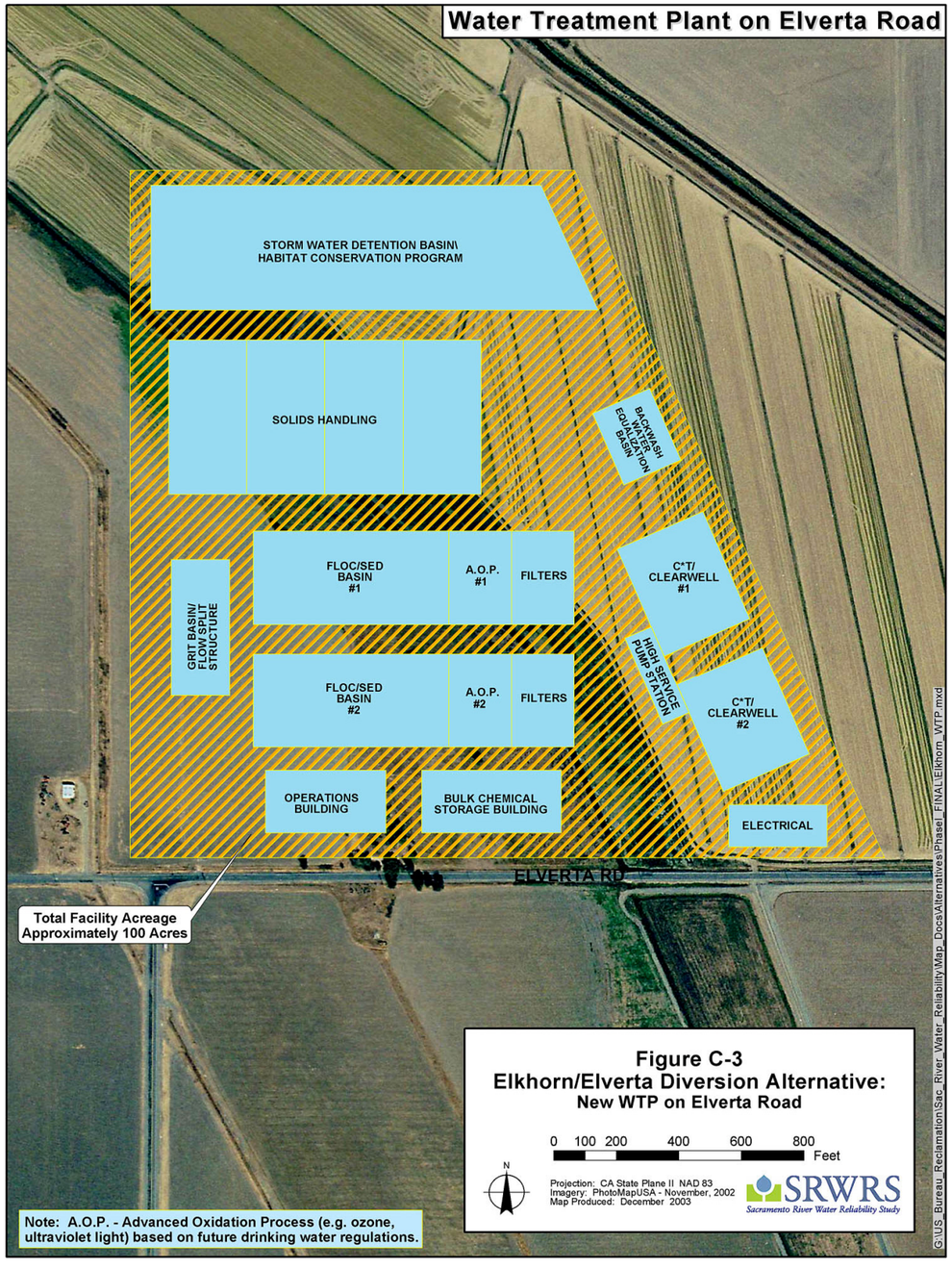


Figure C-3 - Elkhorn/Elverta Diversion Alternative: New WTP on Elverta Road

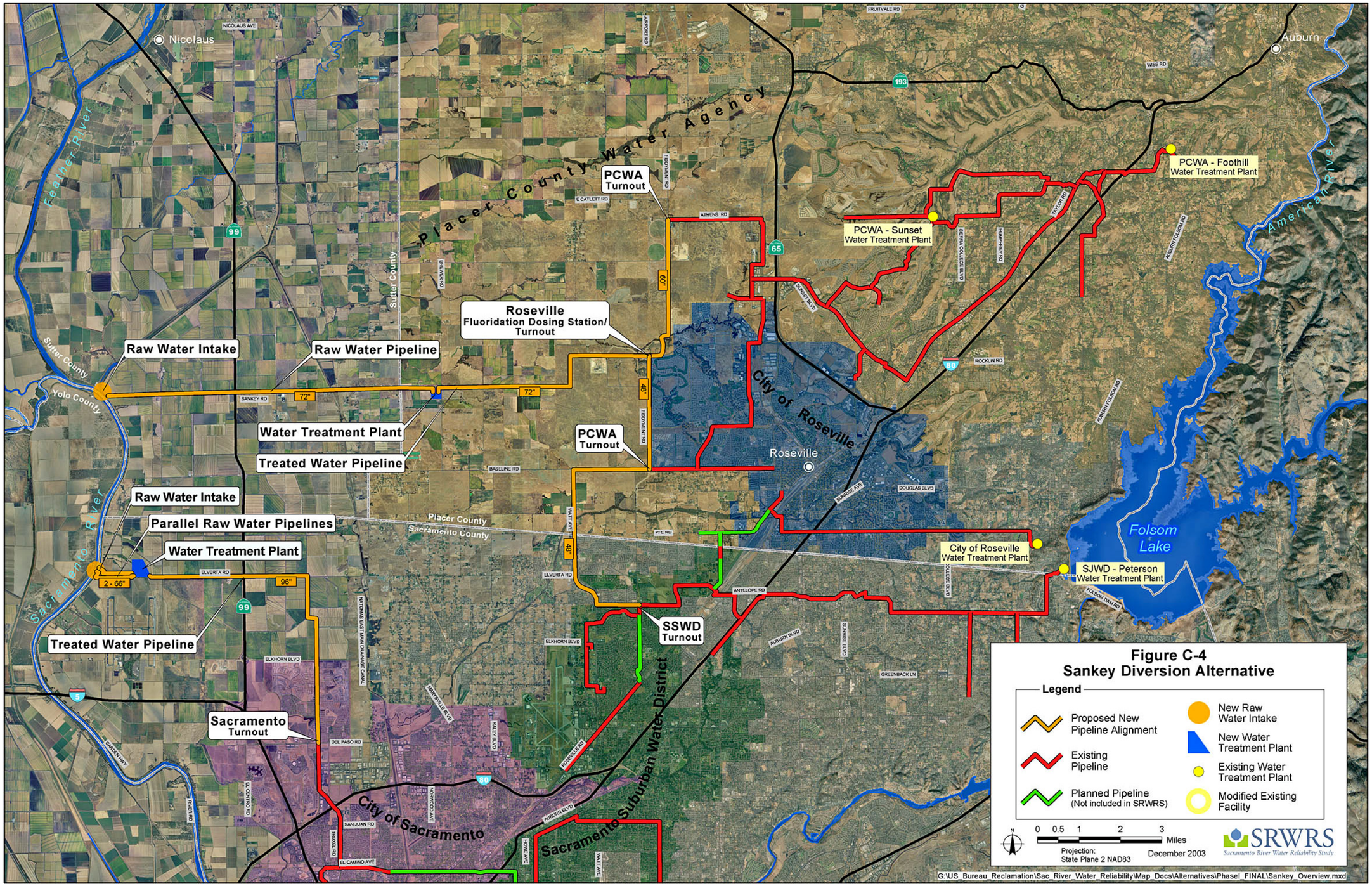
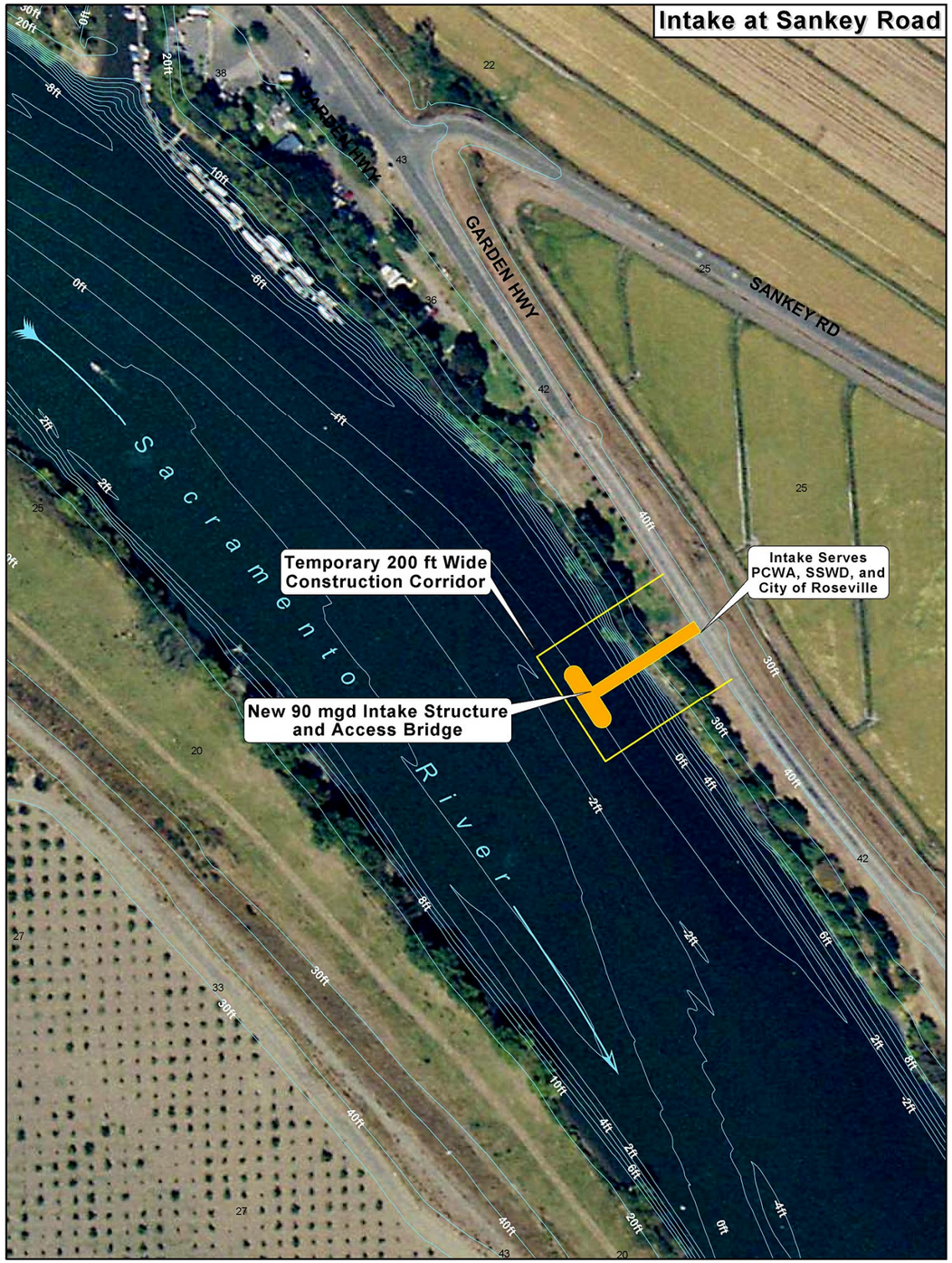


Figure C-4 - Sankey Diversion Alternative



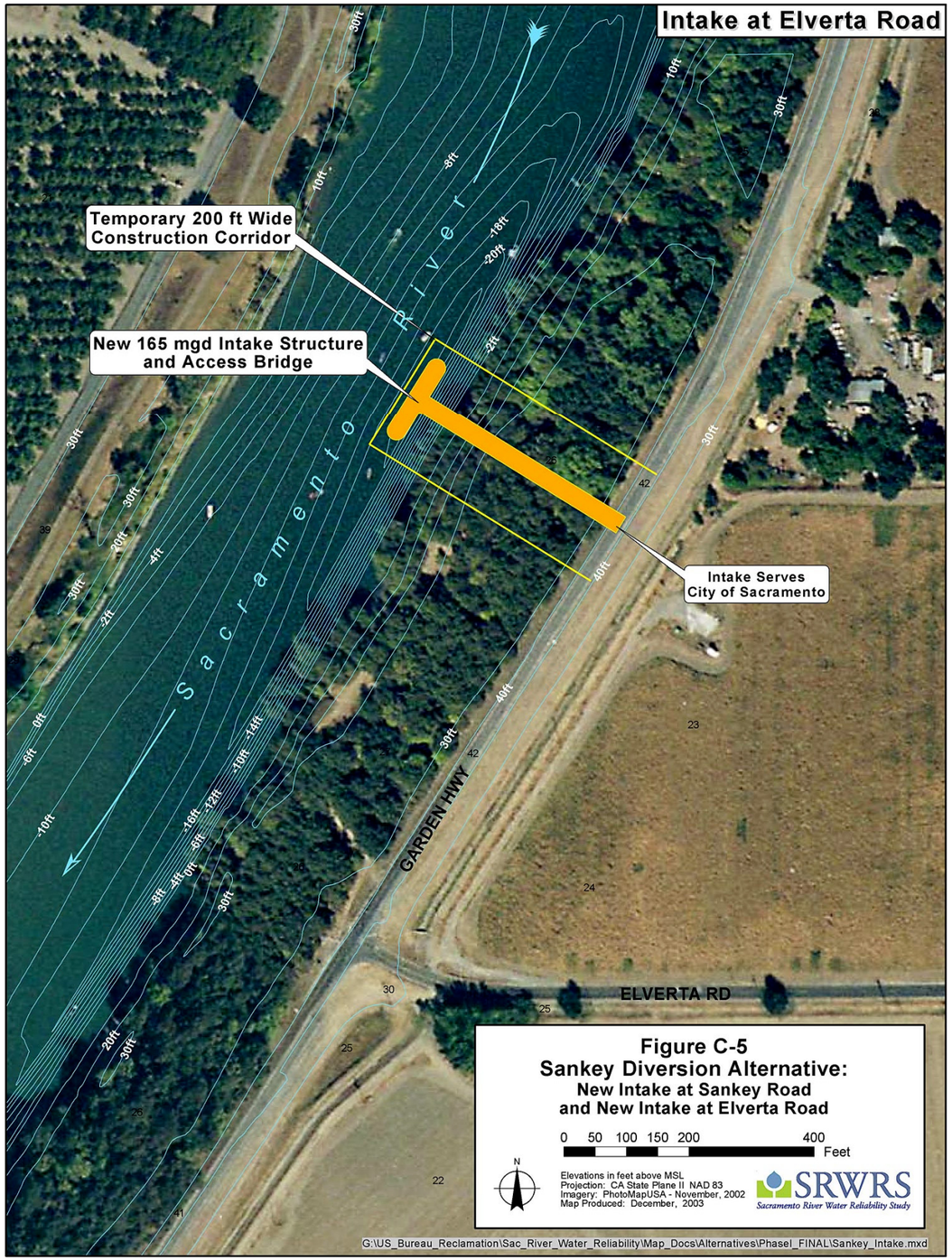
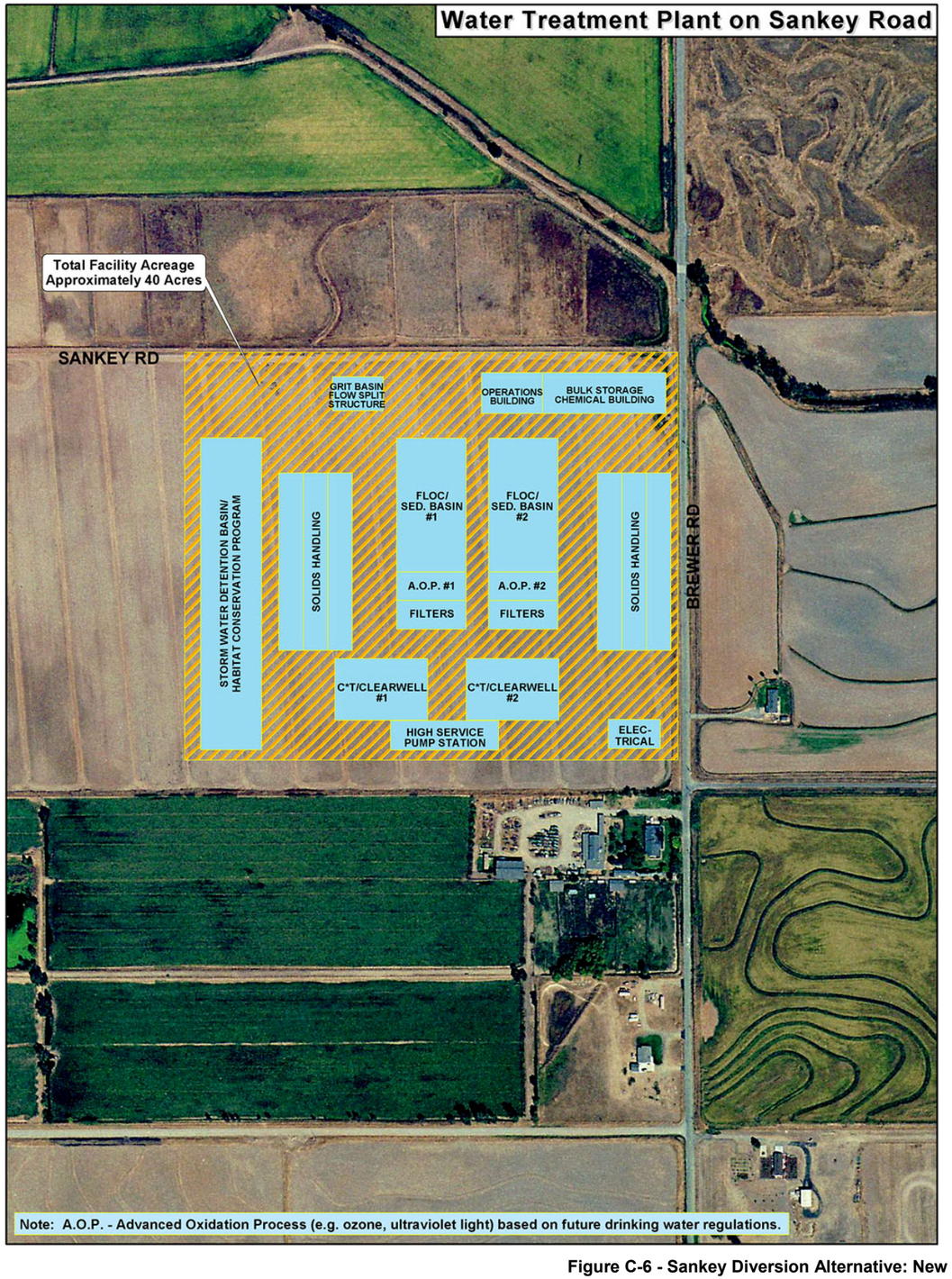


Figure C-5 - Sankey Diversion Alternative: New Intake at Sankey Road and New Intake at Elverta Road



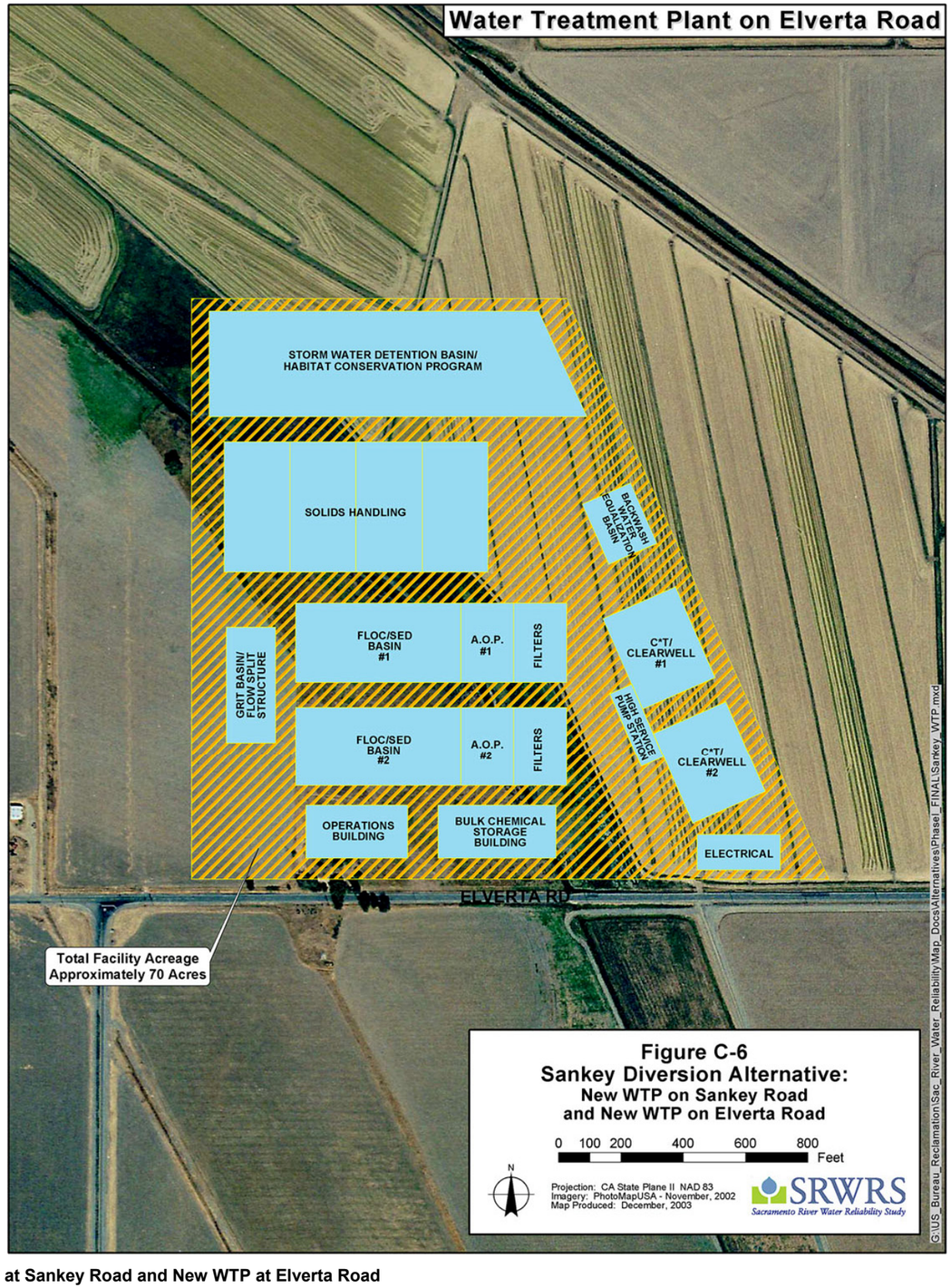


Figure C-6 - Sankey Diversion Alternative: New WTP at Sankey Road and New WTP at Elverta Road

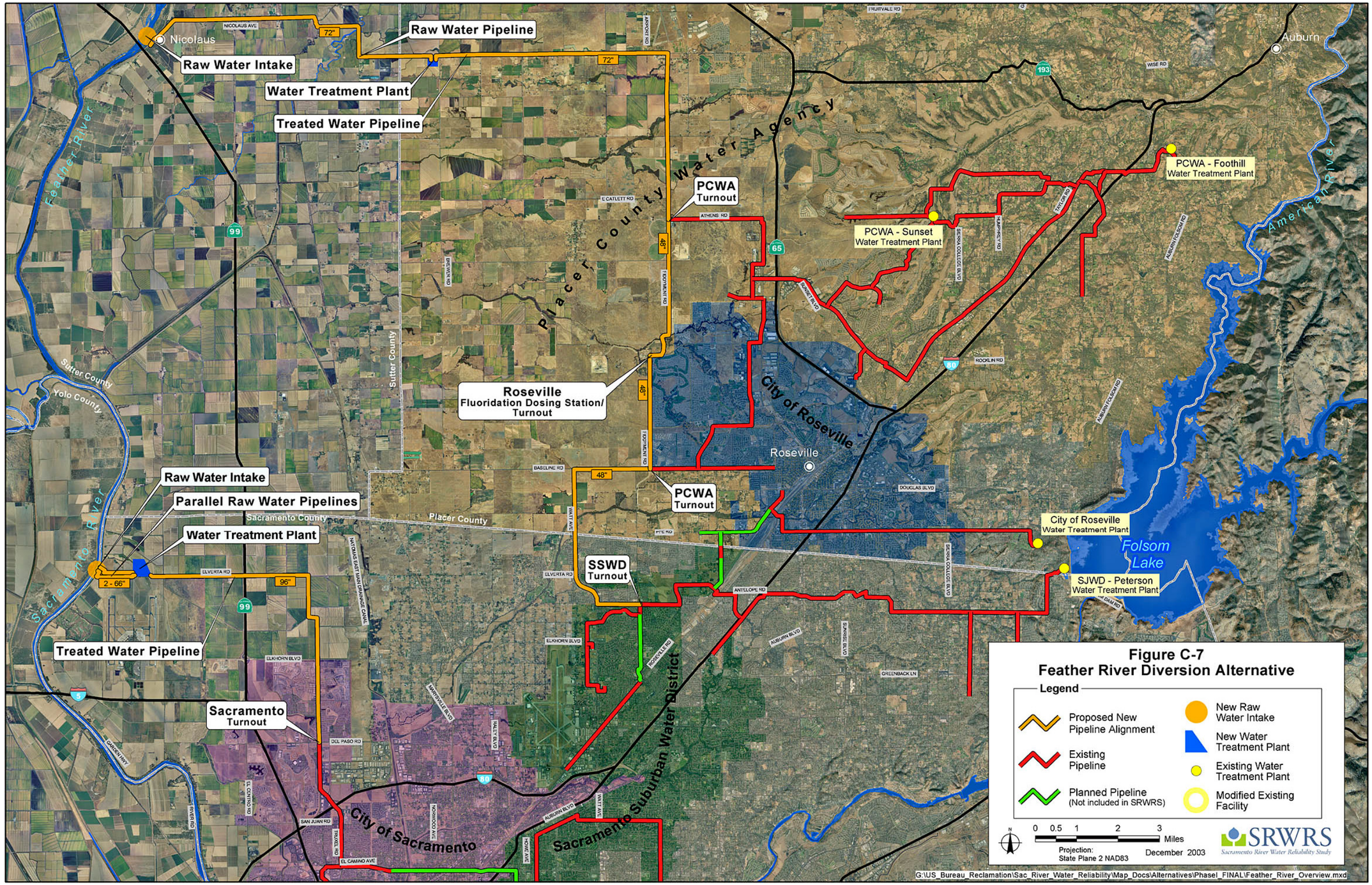
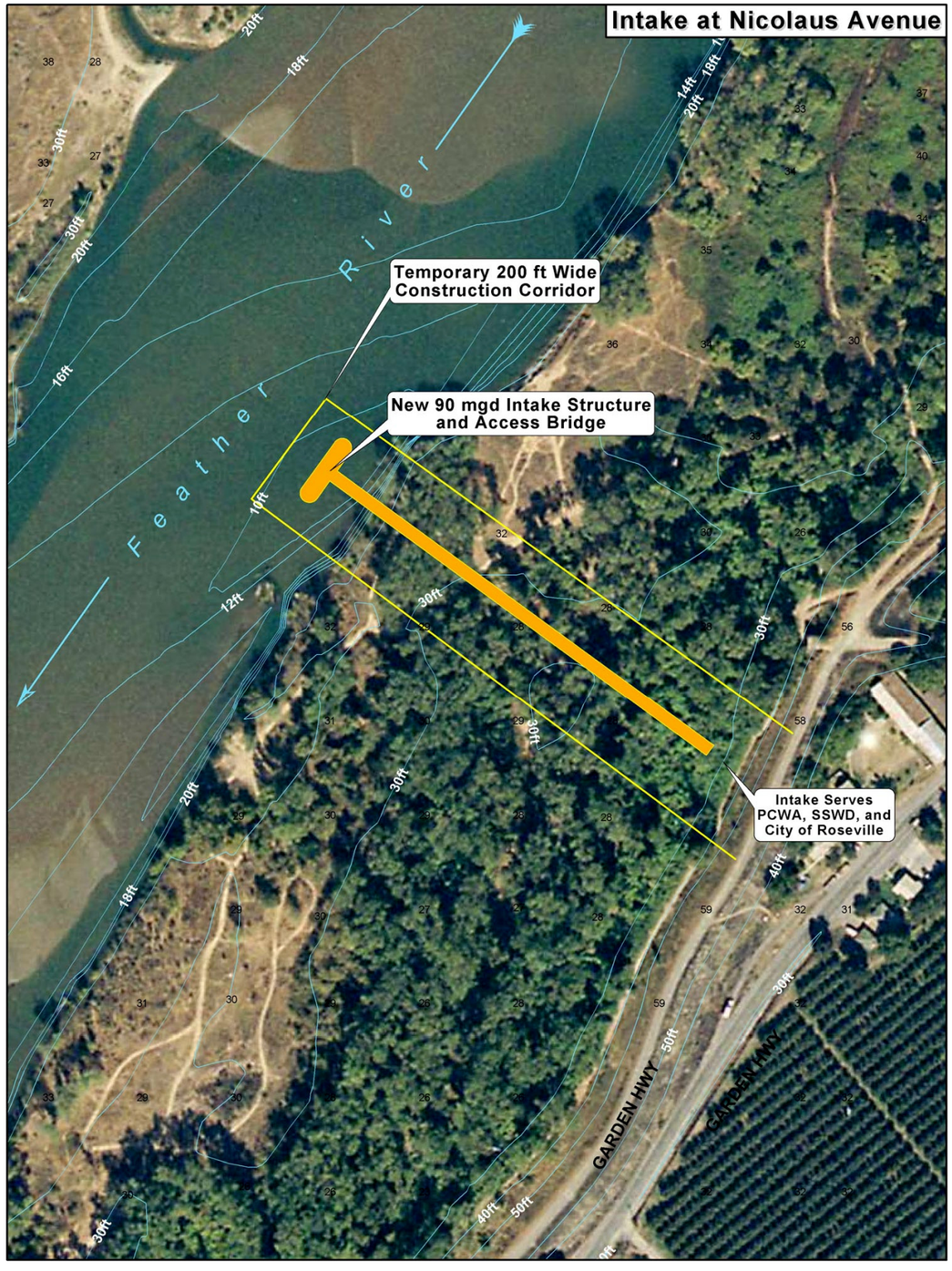


Figure C-7 – Feather River Diversion Alternative



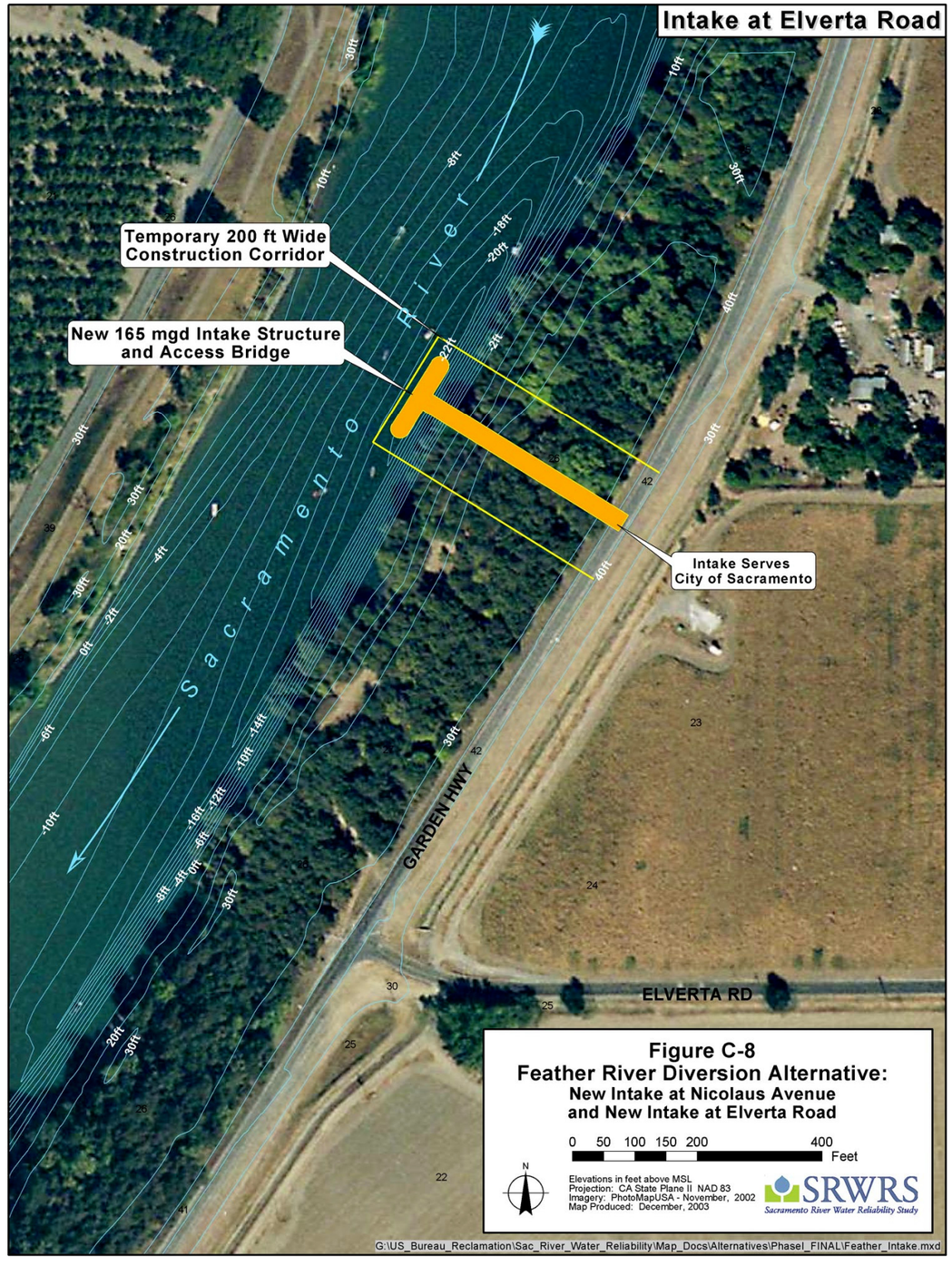


Figure C-8 – Feather River Diversion Alternative: New Intake at Nicolaus Avenue and New Intake at Elverta Road

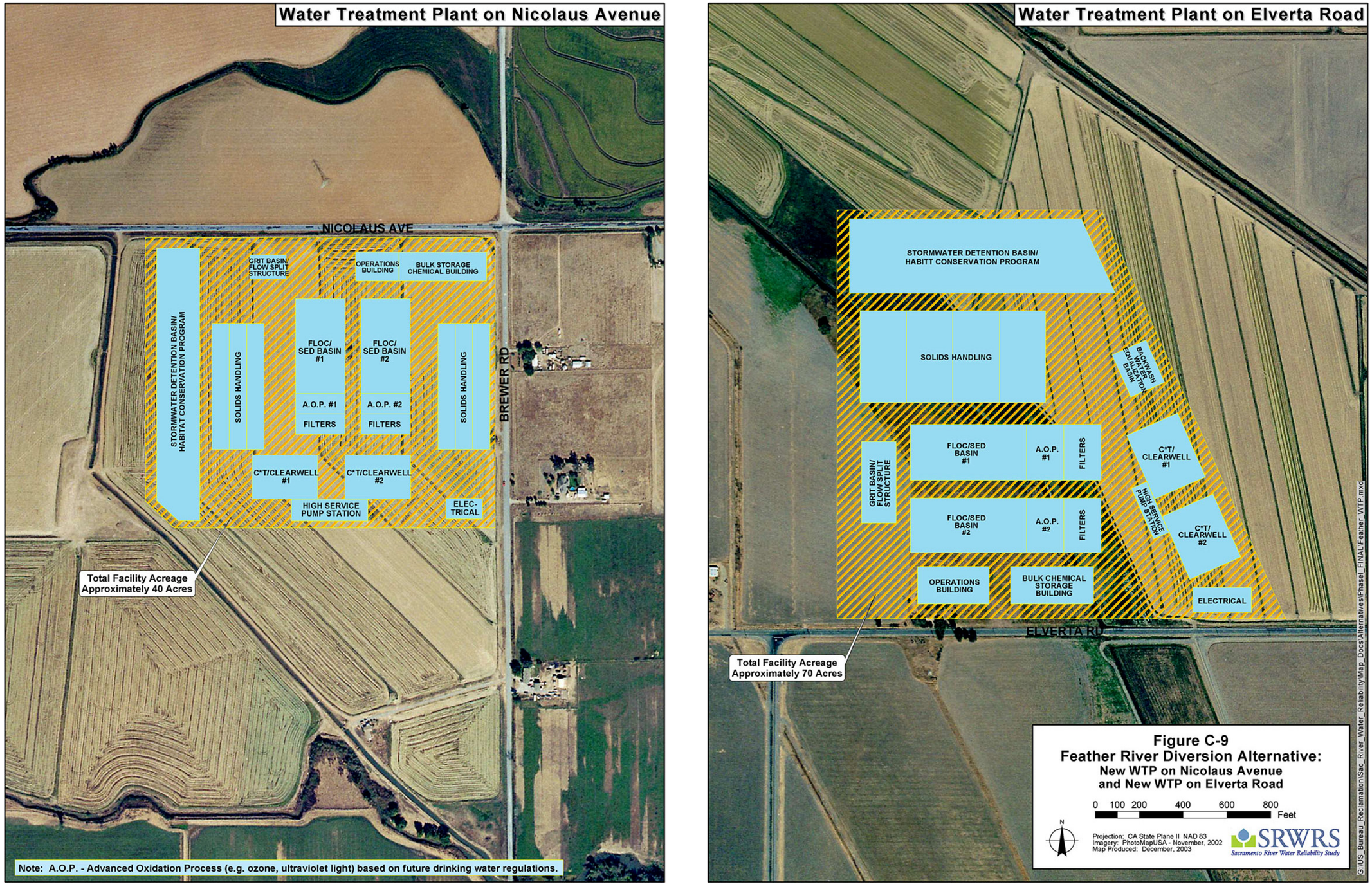


Figure C-9 – Feather River Diversion Alternative: New WTP at Nicolaus Avenue and New WTP at Elverta Road

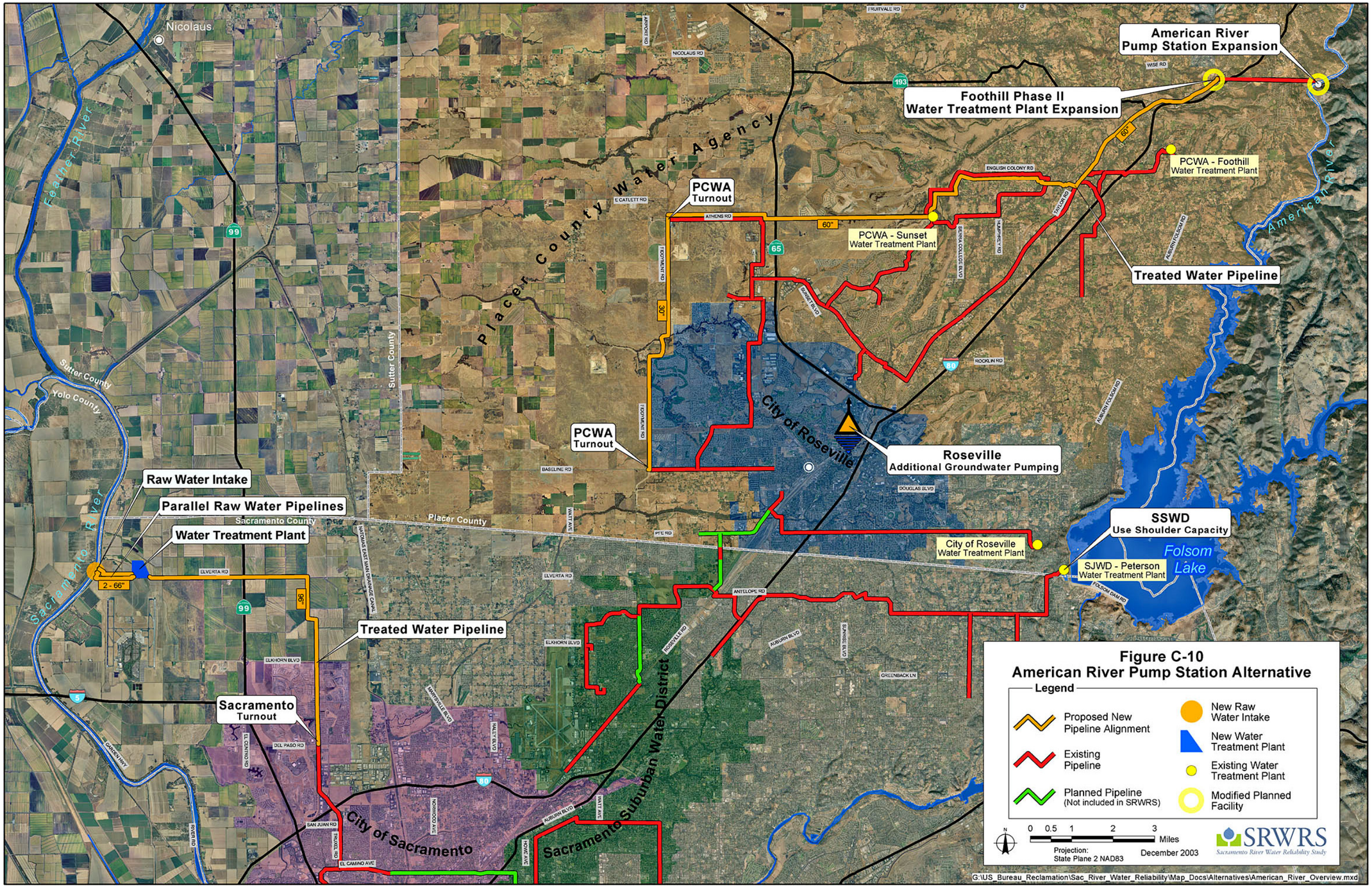
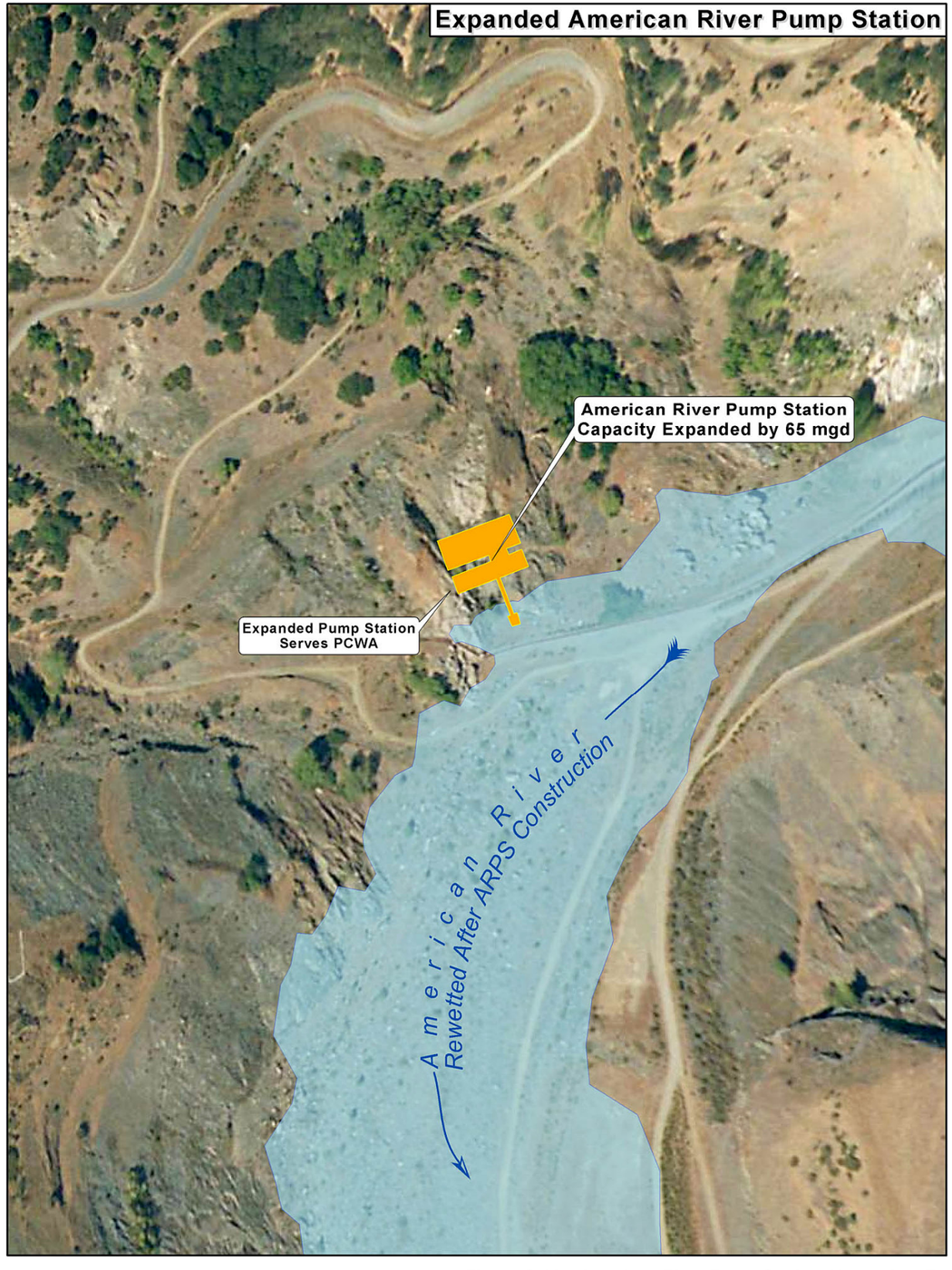


Figure C-10 – American River Pump Station Alternative



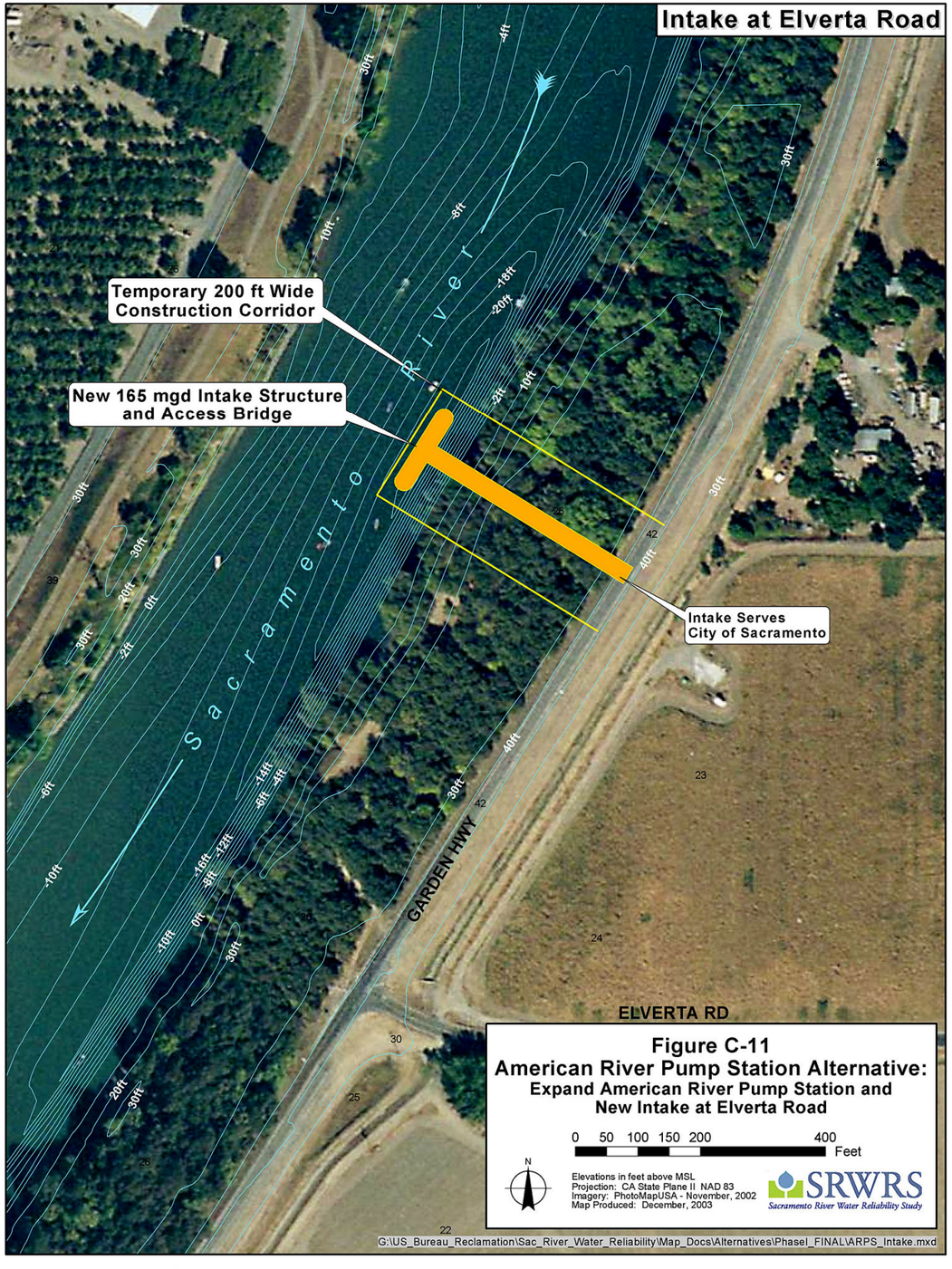


Figure C-11 – American River Pump Station Alternative: Expand American River Pump Station and New Intake at Elverta Road

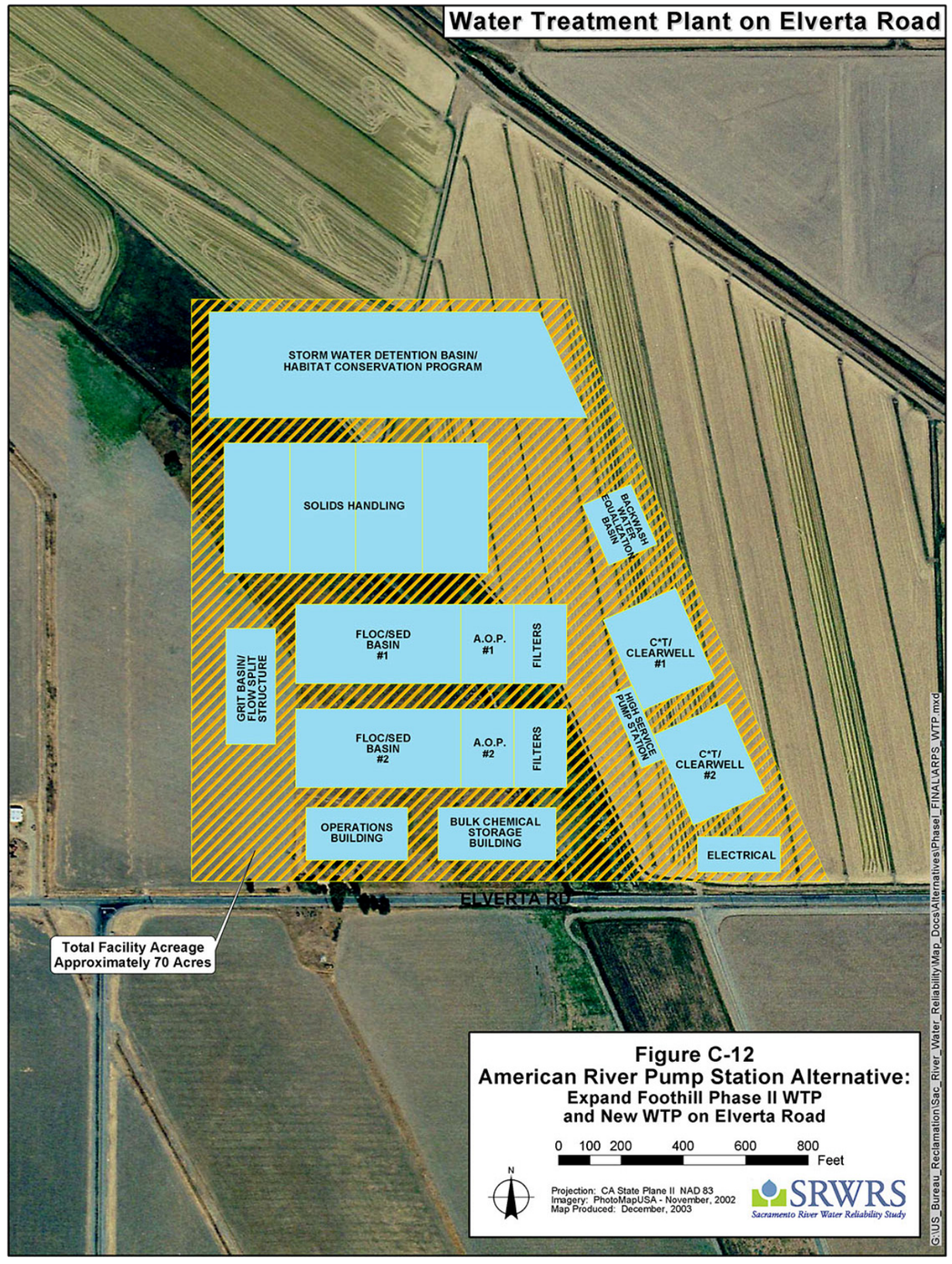


Figure C-12 – American River Pump Station Alternative: Expand Foothill Phase II WTP and New WTP at Elverta Road

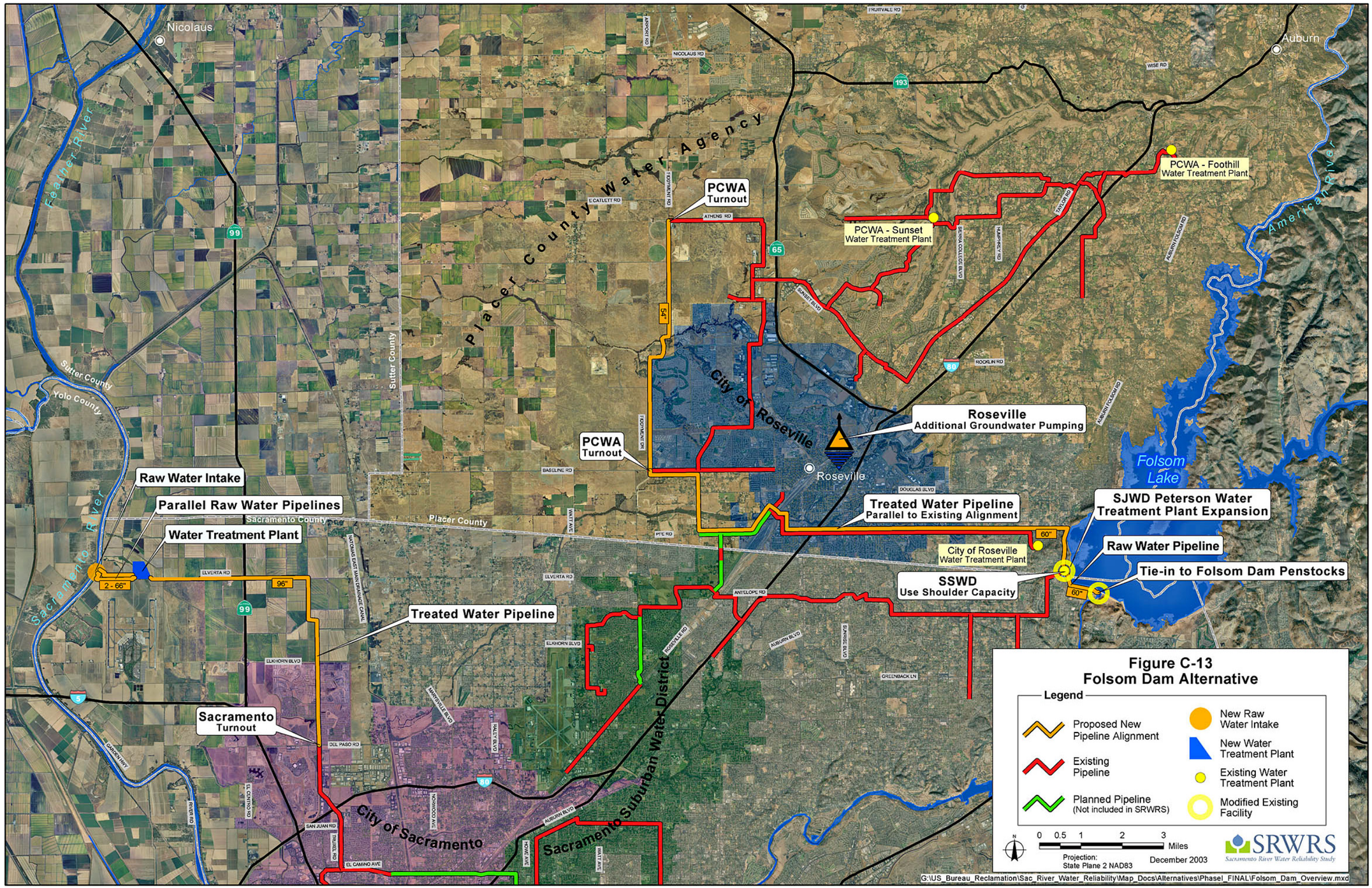
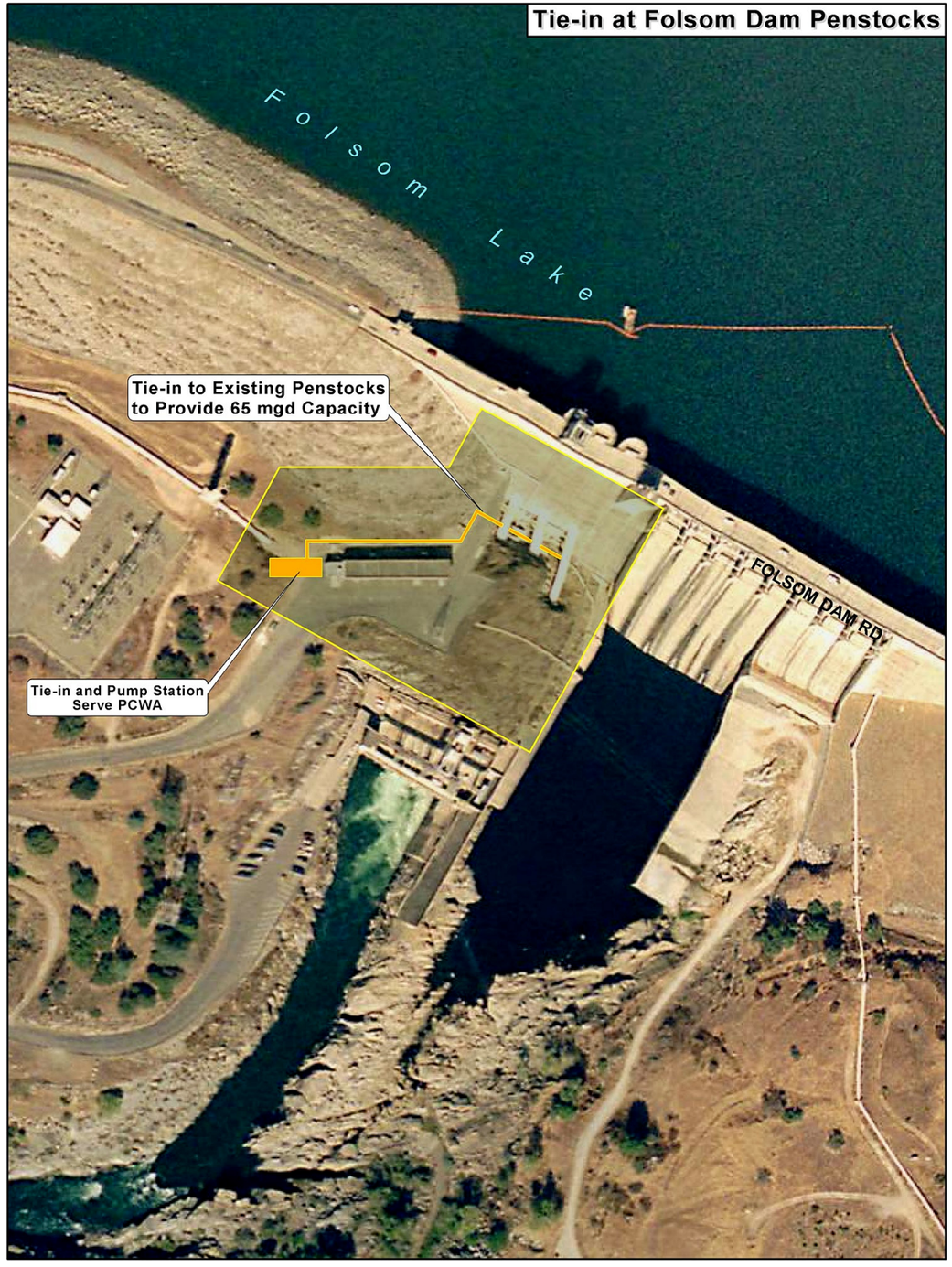


Figure C-13 – Folsom Dam Alternative



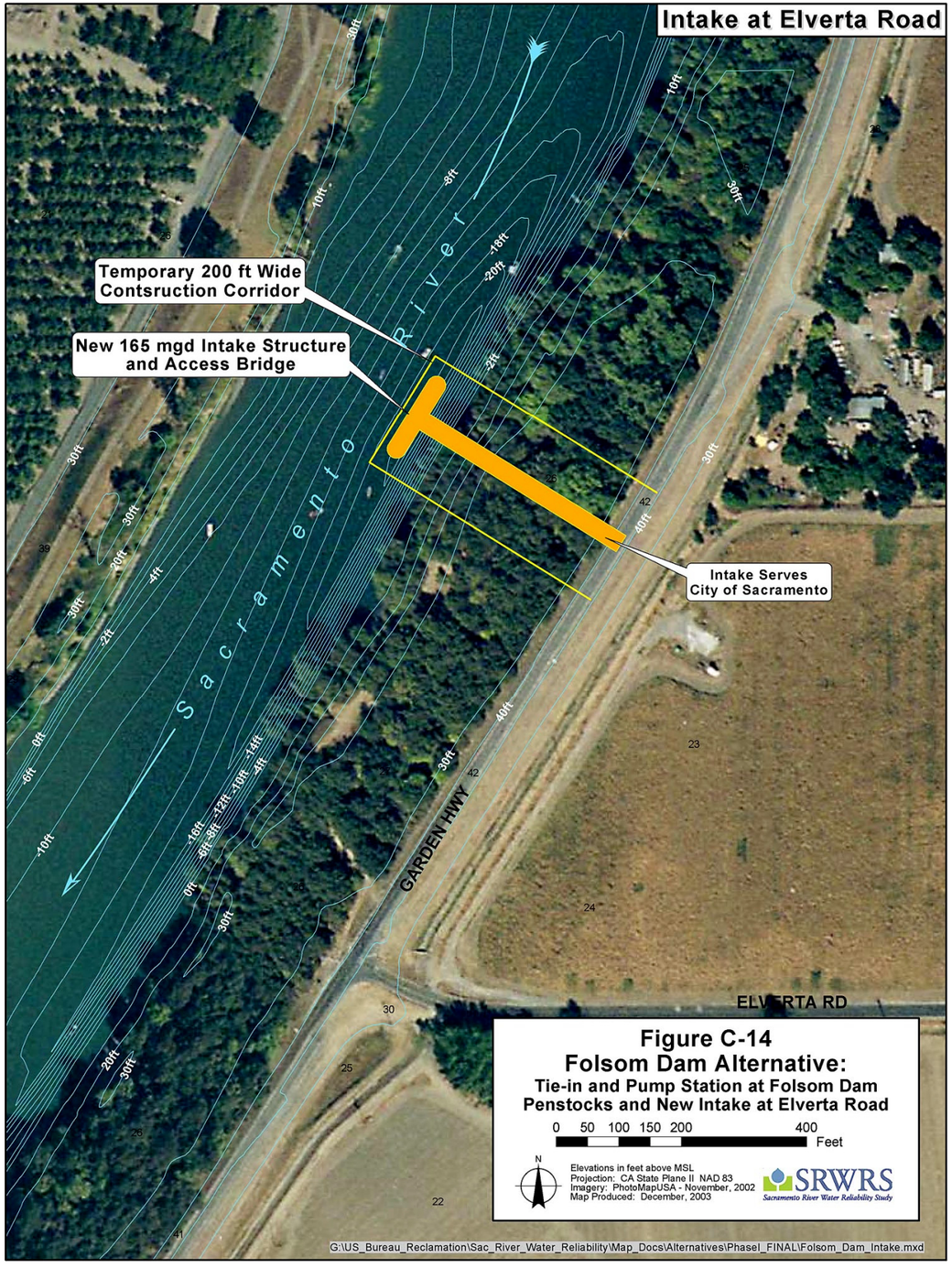


Figure C-14 – Folsom Dam Alternative: Tie-in and Pump Station at Folsom Dam Penstocks and New Intake at Elverta Road

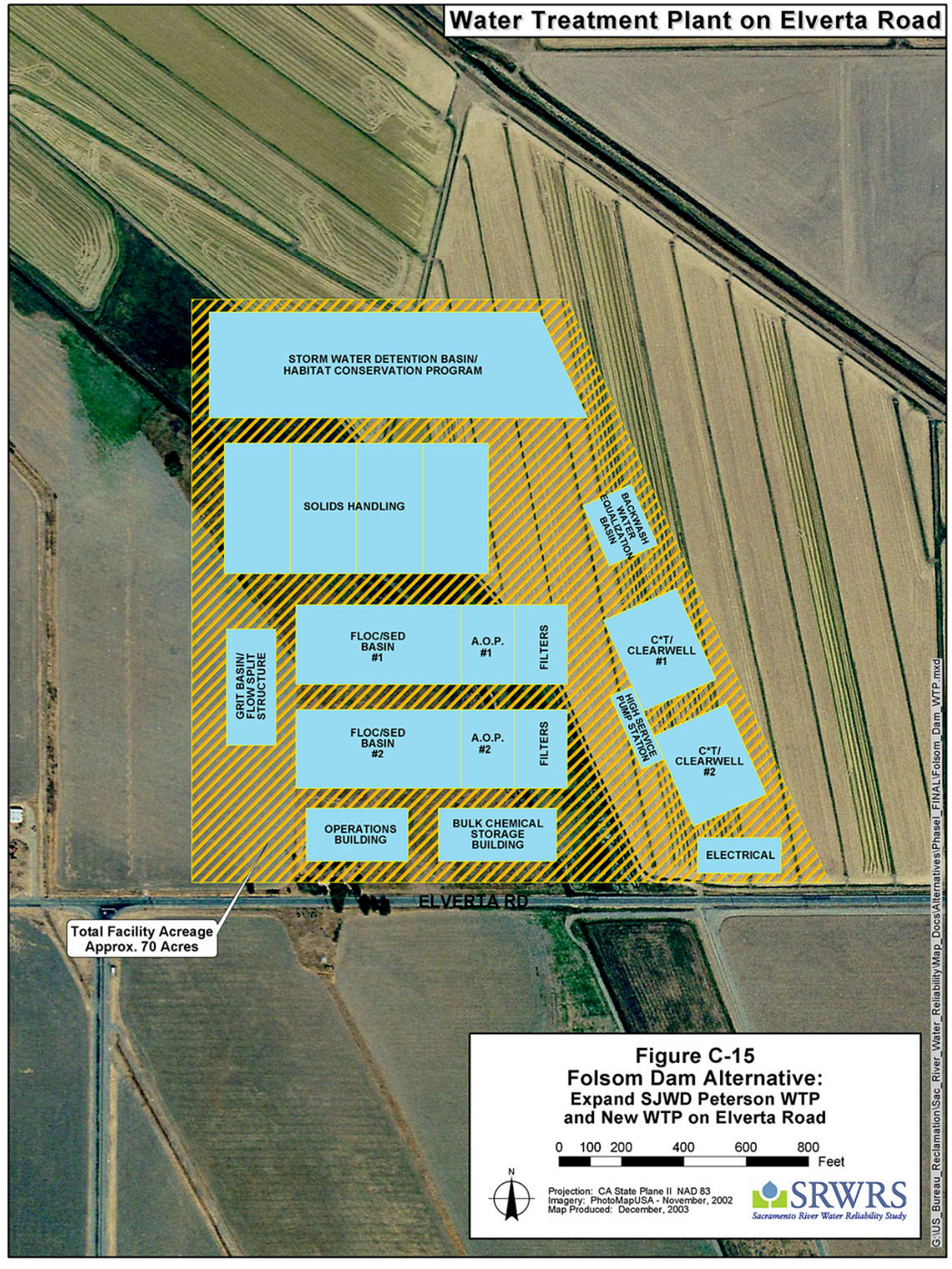


Figure C-15 – Folsom Dam Alternative: Expand SJWD Peterson WTP and New WTP on Elverta Road

SRWRS
Sacramento River Water Reliability Study

Appendix C, Attachment A
Operation and Maintenance Costs

May 2004

Table C - A1
Qualitative Assessment of Operation and Maintenance Costs

	Elkhorn/ Elverta Diversion Alternative	Sankey Diversion Alternative	Feather River Diversion Alternative	ARPS Alternative	Folsom Dam Alternative
Intake	mod	mod/high	high	low/mod	low
Pumping Raw Water	low/mod	mod/high	mod/high	high	low
Treatment (WQ/Chem)	mod/high	high	high	mod/high	low/mod
Solids Handling	high	high	high	low/mod	low
Pumping Treated Water	low/mod	mod/high	mod/high	low	low/mod
Pipeline	high	mod	mod/high	mod/high	mod/high

Factors Considered in Assessment:

Intake	Water Depth, Facility Footprint, River Location
Pumping - Raw Water	Distance, Flow, Pumping Head
Treatment	Raw Water Quality, Chemical Demand, No. Facilities, New vs. Expansion
Solids Handling	Raw Water Quality, Chemical Usage, WTP Location
Pumping - Treated Water	Distance, Flow, Pumping Head
Pipelines	Distance, Above Ground Portions

Table C - A2
Ranking of SRWRS Alternatives for Operation and Maintenance Costs

	Elkhorn/ Elverta Diversion Alternative	Sankey Diversion Alternative	Feather River Diversion Alternative	ARPS Alternative	Folsom Dam Alternative
Intake	2	2.5	3	1.5	1
Pumping Raw Water	1.5	2.5	2.5	3	1
Subtotal	**3.5**	**5**	**5.5**	**4.5**	**2**
Treatment (WQ/Chem)	2.5	3	3	2.5	1.5
Solids Handling	3	3	3	2	1
Pumping Treated Water	1.5	2.5	2.5	1	1.5
Subtotal	**7**	**8.5**	**8.5**	**5.5**	**4**
Pipeline	**3**	**2**	**2.5**	**2.5**	**2.5**
Total	**13.5**	**15.5**	**16.5**	**12.5**	**8.5**

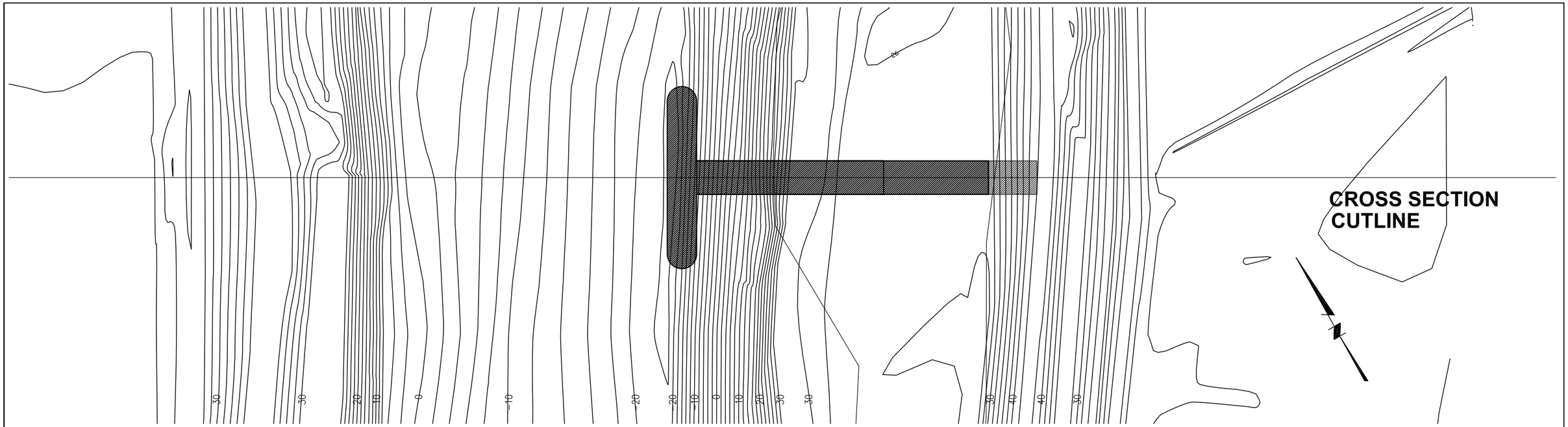
Key to Rankings:

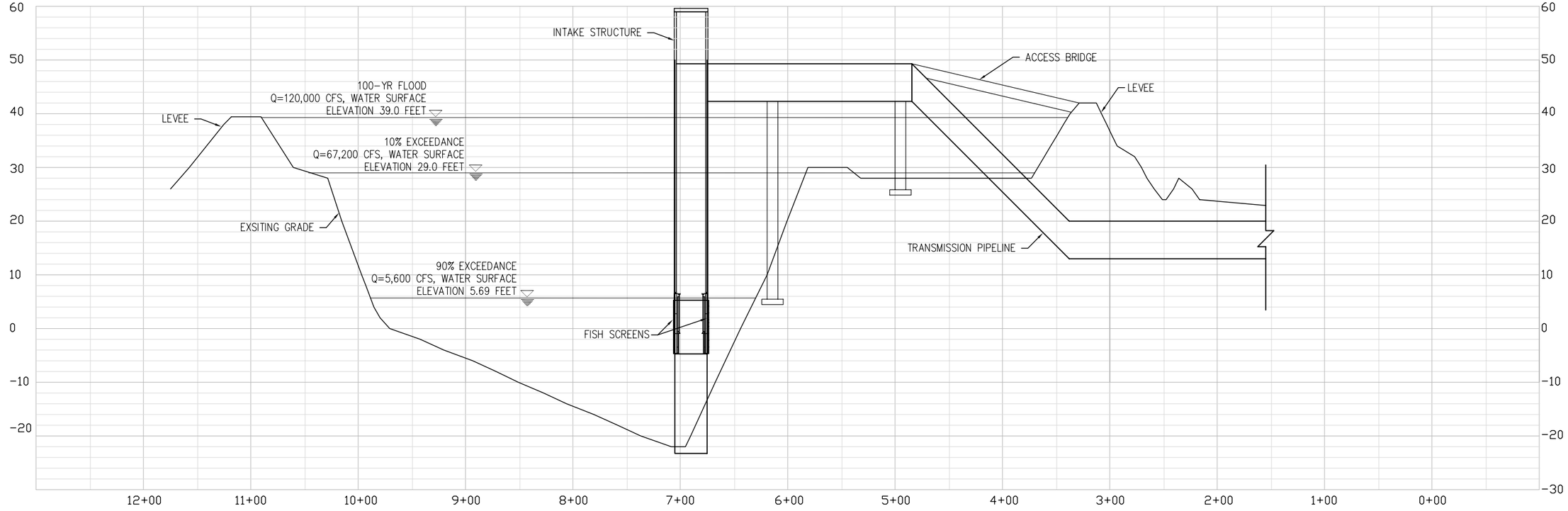
high	3
mod/high	2.5
mod	2
low/mod	1.5
low	1

SRWRS
Sacramento River Water Reliability Study

Appendix C, Attachment B
Intake Conceptual Plans and Sections

May 2004





PLAN
SCALE: 1"=100'

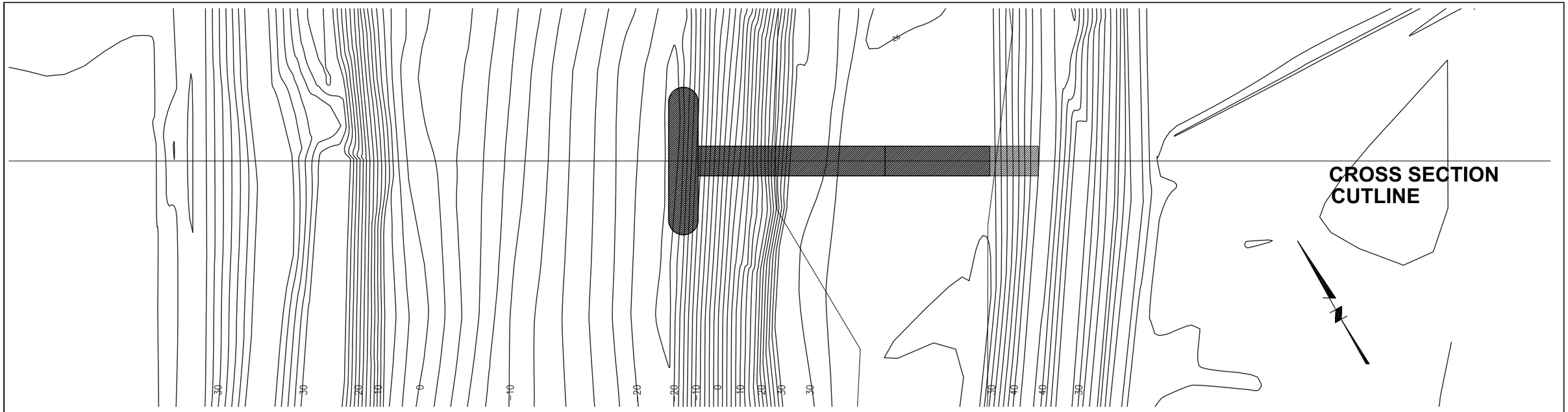
PROFILE
HORIZONTAL SCALE: 1"=100'
VERTICAL SCALE: 1"=20'

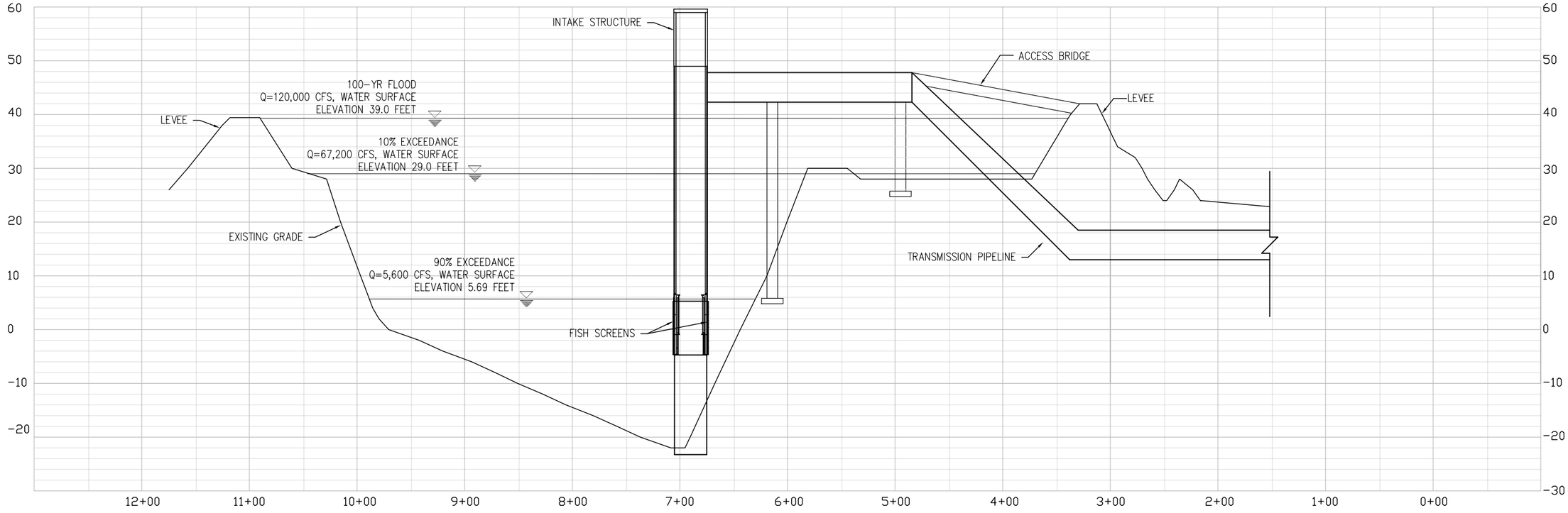
SACRAMENTO RIVER WATER RELIABILITY STUDY

MWH
MONTGOMERY WATSON HARZA

Sacramento, California

FIGURE C-B1
COMBINED INTAKE AT ELVERTA ROAD (RM 74.6)
CONCEPTUAL PLAN AND SECTION





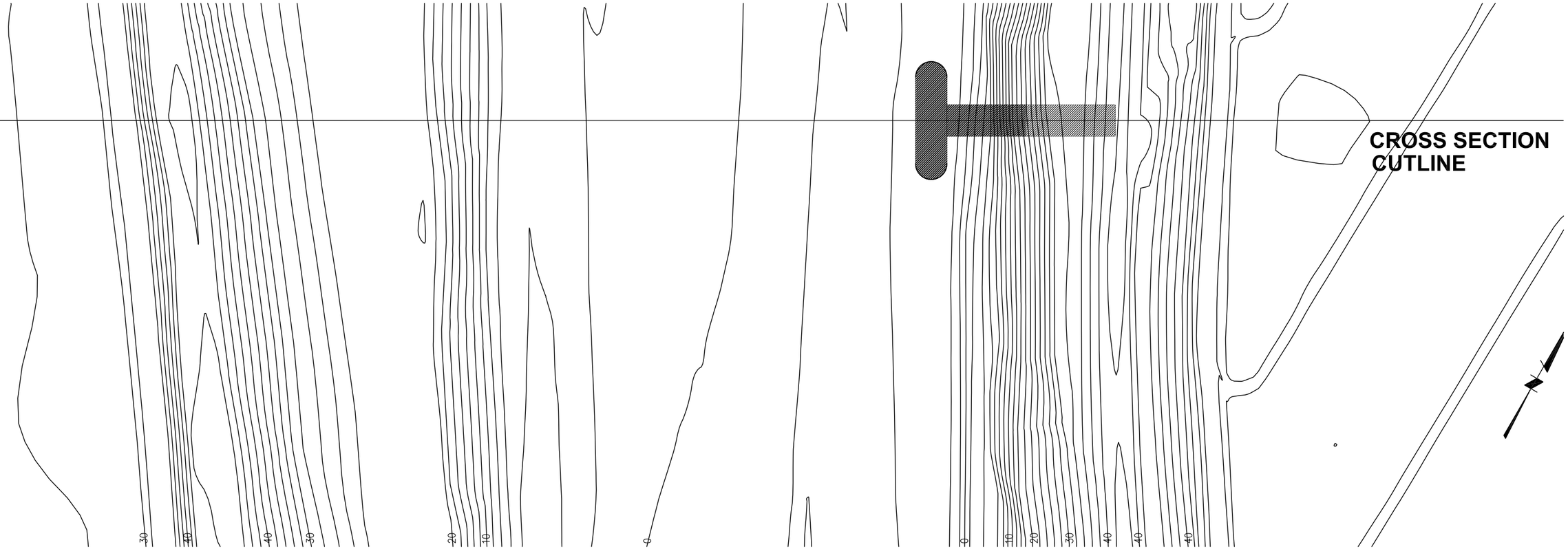
PLAN
SCALE: 1"=100'

PROFILE
HORIZONTAL SCALE: 1"=100'
VERTICAL SCALE: 1"=20'

SACRAMENTO RIVER WATER RELIABILITY STUDY

MWH
MONTGOMERY WATSON HARZA
Sacramento, California

FIGURE C-B2
CITY OF SACRAMENTO INTAKE AT ELVERTA ROAD (RM 74.6)
CONCEPTUAL PLAN AND SECTION



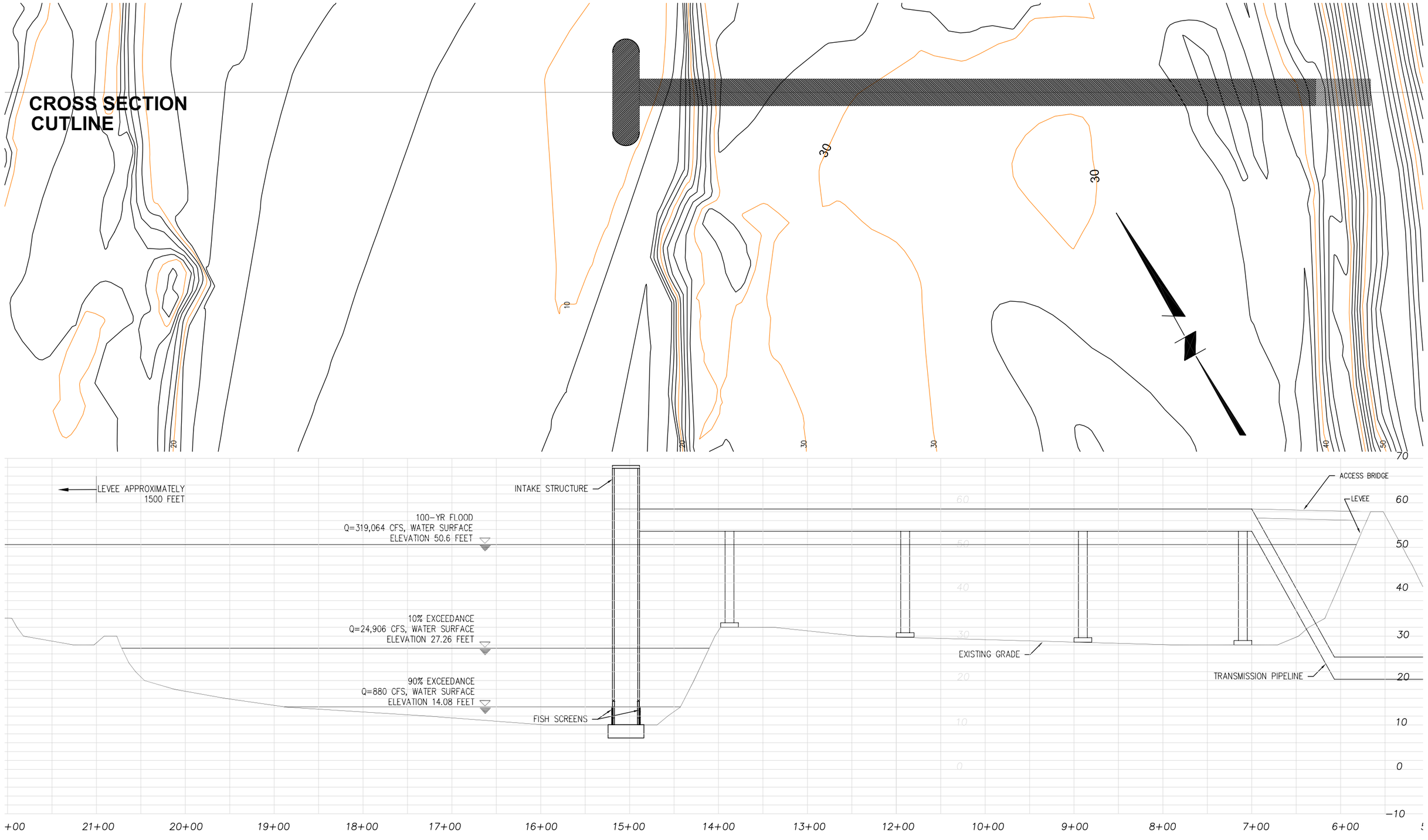
PLAN
SCALE: 1"=100'

PROFILE
HORIZONTAL SCALE: 1"=100'
VERTICAL SCALE: 1"=20'

SACRAMENTO RIVER WATER RELIABILITY STUDY

MWH
MONTGOMERY WATSON HARZA
Sacramento, California

FIGURE C-B3
INTAKE AT SANKEY ROAD (RM 79.0)
CONCEPTUAL PLAN AND SECTION



PLAN
SCALE: 1"=100'

PROFILE
HORIZONTAL SCALE: 1"=100'
VERTICAL SCALE: 1"=20'

SACRAMENTO RIVER WATER RELIABILITY STUDY

MWH
MONTGOMERY WATSON HARZA

Sacramento, California

FIGURE C-B4
INTAKE AT NICOLAUS AVE.-FEATHER RIVER (RM 9.6)
CONCEPTUAL PLAN AND SECTION

SRWRS
Sacramento River Water Reliability Study

Appendix C, Attachment C
Comparison of Elkhorn and Elkhorn/Elverta Diversion Locations

May 2004

Table C-C1
Comparison of Diversion at the NMWC Elkhorn Site

Comparison Item		Natomas Mutual Water Company			SRWRS Cost-Sharing Partners		
		Advantage	Neutral	Disadvantage	Advantage	Neutral	Disadvantage
1	Location of Diversion	Existing Intake Location					Shallow Water - Inferior Site
2	Intake Design			Shallow Water - Larger Footprint			Shallow Water - Larger Footprint
3	Fish Screen Configuration			Shallow Water - Incline Plate			Shallow Water - Incline Plate
4	Timing of Engineering Documentation	Feasibility Work Ongoing				Feasibility Work Beginning	
5	Timing of Environmental Documentation	Environmental Work Near Complete				Environmental Work Beginning	
6	Proximity to Residential Development			Closer - Impacts Greater			Closer - Impacts Greater
7	Construction Cost			Larger Facility - Higher Cost			Larger Facility - Higher Cost
8	Funding Sources	Construction Funded by CALFED for Ag Use				Locally Funded	

Table C-C2
Comparison of Diversion at the SRWRS Elkhorn/Elverta Site

Comparison Item		Natomas Mutual Water Company			SRWRS Cost-Sharing Partners		
		Advantage	Neutral	Disadvantage	Advantage	Neutral	Disadvantage
1	Location of Diversion			Located Away From Existing Diversion	Deeper Water - Technical Superior		
2	Intake Design	Deeper Water - Smaller Footprint			Deeper Water - Smaller Footprint		
3	Fish Screen Configuration	Deeper Water - Vertical Plate			Deeper Water - Vertical Plate		
4	Timing of Engineering Documentation			Feasibility Work Ongoing		Feasibility Work Beginning	
5	Timing of Environmental Documentation			Environmental Work Near Complete		Environmental Work Beginning	
6	Proximity to Residential Development	Further Away - Lower Impacts			Further Away - Lower Impacts		
7	Construction Cost	Smaller Facility - Lower Cost			Smaller Facility - Lower Cost		
8	Funding Sources			CALFED Funding May Not Be Secure Since Not All Ag		Locally Funded	

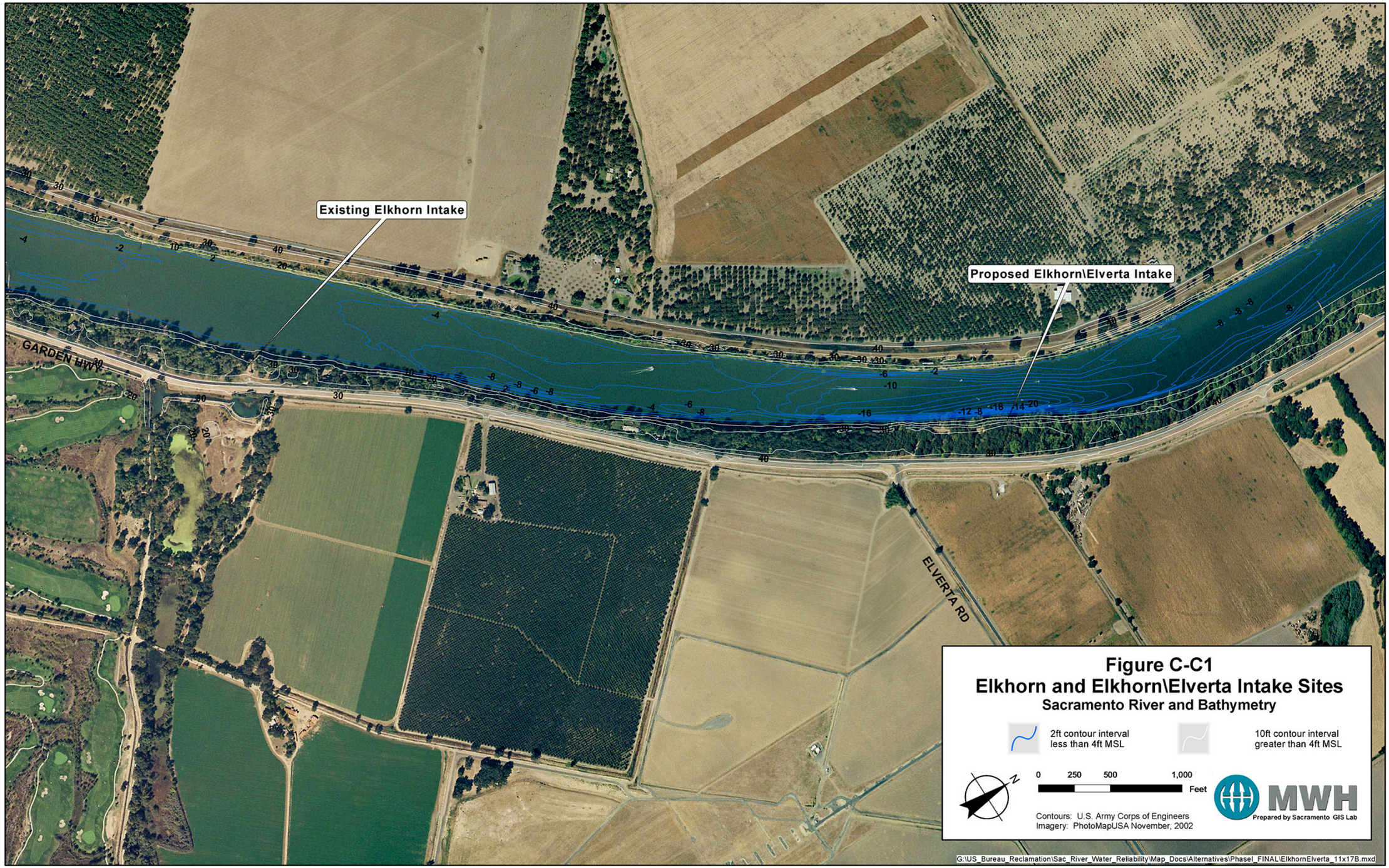


Figure C-C1 – Elkhorn and Elkhorn\Elverta Intake Sites: Sacramento River and Bathymetry